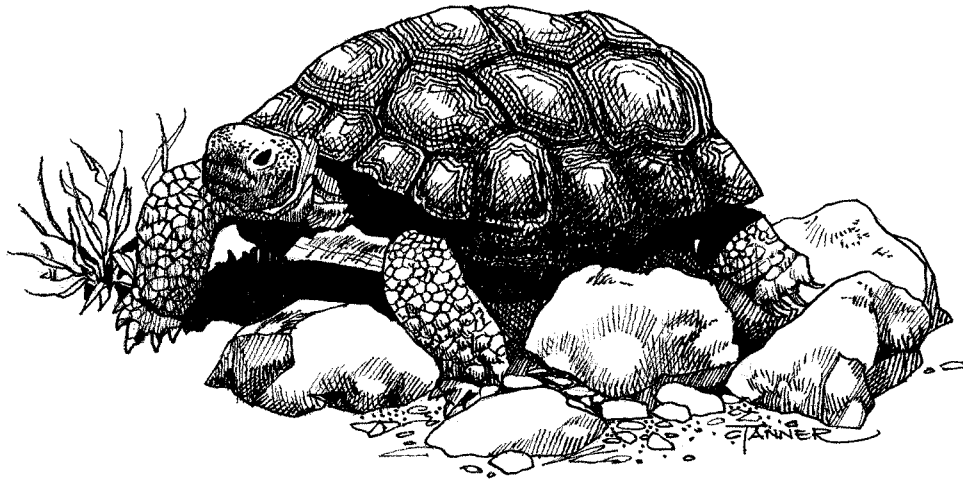


# STATUS OF THE SONORAN POPULATION OF THE DESERT TORTOISE IN ARIZONA: AN UPDATE

Edited by

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## PREFACE

The Arizona Interagency Desert Tortoise Team (AIDTT) consists of biologists and managers assigned to the Team by the following agencies (alphabetically): Arizona Game and Fish Department; Arizona State Land Department; U.S. Department of Agriculture Forest Service; U.S. Department of Defense Luke Air Force Base, Marine Corps Air Station-Yuma, and U.S. Army Yuma Proving Ground; and U.S. Department of Interior Bureau of Land Management, Bureau of Reclamation, Bureau of Indian Affairs, Fish and Wildlife Service, Geological Survey, and National Park Service. In accordance with a Memorandum of Understanding, finalized in 1995 and signed by the above agencies, the Team serves as a forum to discuss desert tortoise issues, with a specific objective to conduct and coordinate research and management efforts. This interagency cooperation is intended to: (1) ensure the perpetuation of the species and (2) prevent loss and improve quality of habitat in Arizona. The AIDTT is also open to participation by other federal, state, or tribal agencies interested in the conservation of the desert tortoise in Arizona, and it recognizes the participation of the Tohono O'odham Nation, in particular.

## ACKNOWLEDGEMENTS

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# STATUS OF THE SONORAN POPULATION OF THE DESERT TORTOISE IN ARIZONA: AN UPDATE

## INTRODUCTION

### PURPOSE AND NEED

On August 20, 1980, the U.S. Fish and Wildlife Service (FWS) listed the Beaver Dam Slope, Utah, population of the desert tortoise *Gopherus agassizii* as threatened with critical habitat under the federal Endangered Species Act (ESA). On September 14, 1984, FWS received a petition from the Environmental Defense Fund, Natural Resources Defense Council, and Defenders of Wildlife to list all other populations of the desert tortoise in Arizona, California, and Nevada as endangered. In a September 1985 petition finding, and in subsequent annual findings through 1989, FWS determined that listing of the desert tortoise in the three state area was warranted, but precluded by higher priority listing actions. The petitioners presented new information in a May 1989 petition to FWS and argued that the tortoise should be listed under the emergency listing process. On August 4, 1989, FWS listed the Mojave population of the desert tortoise (tortoises west and north of the Colorado River) as endangered under emergency listing procedures (FWS 1989). The Mojave population was listed as threatened under the ESA on April 2, 1990, under normal listing procedures (FWS 1990). A factor in the listing was an epidemic upper respiratory tract disease (URTD) in some Mojave tortoise populations. Critical habitat, including 2,068,086 acres (836,928 ha) in Arizona, was designated for Mojave tortoises on February 8, 1994 (FWS 1994a).

As a result of listing and designation of critical habitat, the Mojave population of the desert tortoise was afforded considerable protection. The provisions of sections 4(f), 7(a)(1, 2), 9, and 10(a)(1)(B) of the ESA contributed to protection of habitat and individual desert tortoises, particularly on federal lands, but also in areas covered by habitat conservation plans. A recovery plan was developed for the Mojave population (FWS 1994b) and, as of this writing, is either being implemented or planning is underway to allow its implementation throughout the range of the population. Even before listing, the desert tortoise had been recognized as a species of concern by some agencies. Collection was prohibited by state laws; the National Park Service (NPS) had in place policies to protect natural values, including desert tortoises and their habitats; and the Bureau of Land Management (BLM) adopted a Rangewide Management Plan (Spang et al. 1988) to protect tortoise habitat on BLM lands in the four state region.

In 1991, the FWS ruled that listing of the Sonoran population (south and east of the Colorado River) was not warranted (FWS 1991). This finding was based on the following: 1) Sonoran desert tortoises are typically found in many seemingly isolated mountain ranges that would likely inhibit a rangewide spread of infectious disease, 2) no evidence of pandemic disease was present in the Sonoran population, 3) the rocky habitats of the Sonoran population are less susceptible to human disturbance than the typical flatland habitats of the Mojave tortoise, 4) an apparent lack of serious threats in Mexico, and 5) a 1990 status report on the Sonoran population that clarified threats to the Sonoran population and provided the biological basis for the finding (Barrett and Johnson 1990). As a result of this finding, the benefits afforded the Mojave population as a result of listing and designation of

critical habitat were not extended to the Sonoran population in Arizona. Most of the research and management efforts for the species have been directed to the Mojave population. Nevertheless, land management agencies, Arizona Game and Fish Department (AGFD), and FWS recognized a need to continue monitoring the status of the Sonoran population and, if necessary, take action to provide additional conservation.

The Arizona Interagency Desert Tortoise Team (AIDTT) was formed in 1985 and chartered by way of a 1994 Memorandum of Understanding. The AIDTT was charged with coordinating research and management for the desert tortoise in Arizona and for developing the *Management Plan for the Sonoran Desert Population of the Desert Tortoise in Arizona*, completed in 1996. The Management Plan recommended establishment of Sonoran Desert Management Areas (SDMAs), which would be areas managed for long-term viability of tortoise populations and the ecosystem upon which those populations depend. As the AIDTT began the job of identifying such areas, it became clear that an updated status report, one that summarized current information on densities and population trends, as well as biology, conservation, and management of the Sonoran population, was needed as a baseline for delineating SDMA boundaries. Many of the land management agencies in Arizona have put in place management (wilderness designations, BLM habitat categories and associated management, vehicle restrictions, etc.) that benefit the desert tortoise, but management decisions have not always considered conservation needs on a regional or larger scale that crosses jurisdictional boundaries. Furthermore, in some cases, management designations that benefit the tortoise, such as wilderness and wildlife refuge boundaries, were established primarily for reasons other than tortoise management and may not provide ideal SDMA boundaries. An updated status report could assemble a cross-agency, cross-jurisdictional picture of current tortoise management in Arizona and allow an assessment of current management and where improvements might be possible.

The purpose of this report is to update the *Status Summary for the Desert Tortoise in the Sonoran Desert* (Barrett and Johnson 1990) and provide the information necessary to make regional or population-based decisions about desert tortoise management. The objectives of this report are two-fold: 1) provide a brief summary of the biology of the Sonoran desert tortoise, with numerous references to additional information, and 2) assemble a current, comprehensive picture of management and conservation efforts that benefit the Sonoran population. The information provided in these 2 sections would then provide the basis for an analysis of the adequacy of current management to conserve viable populations of the Sonoran desert tortoises statewide. This analysis could be used by land managers and others to better manage for desert tortoises across agency boundaries and to identify multi-jurisdictional SDMAs as recommended by the AIDTT's 1996 management plan. In its role as a forum for coordinating tortoise management, the AIDTT is uniquely qualified to assemble and assess cross-jurisdictional status information for the Sonoran desert tortoise throughout Arizona.

## ECOLOGY AND NATURAL HISTORY

## DISTRIBUTION AND HABITAT OF THE SONORAN POPULATION

South of the Grand Canyon, desert tortoises occur near Pearce Ferry in Mohave County, to the south beyond the International Boundary, and at many scattered locations in between (Fig. 1). The northeastern-most tortoise records in Arizona occur along the Salt River near Roosevelt Lake in Gila County, although populations here have not been confirmed with recent observations. The middle San Pedro River drainage in Cochise County harbors the eastern-most substantial tortoise populations. Desert tortoise observations have been confirmed in extreme southeastern Cochise County, but most probably represent released captives (pets). Tortoises have been found as far southwest as the Barry M. Goldwater Range, Yuma Proving Ground, and the Cabeza Prieta National Wildlife Refuge, but densities appear to be lower, and distribution is less well known, in southwest Arizona.

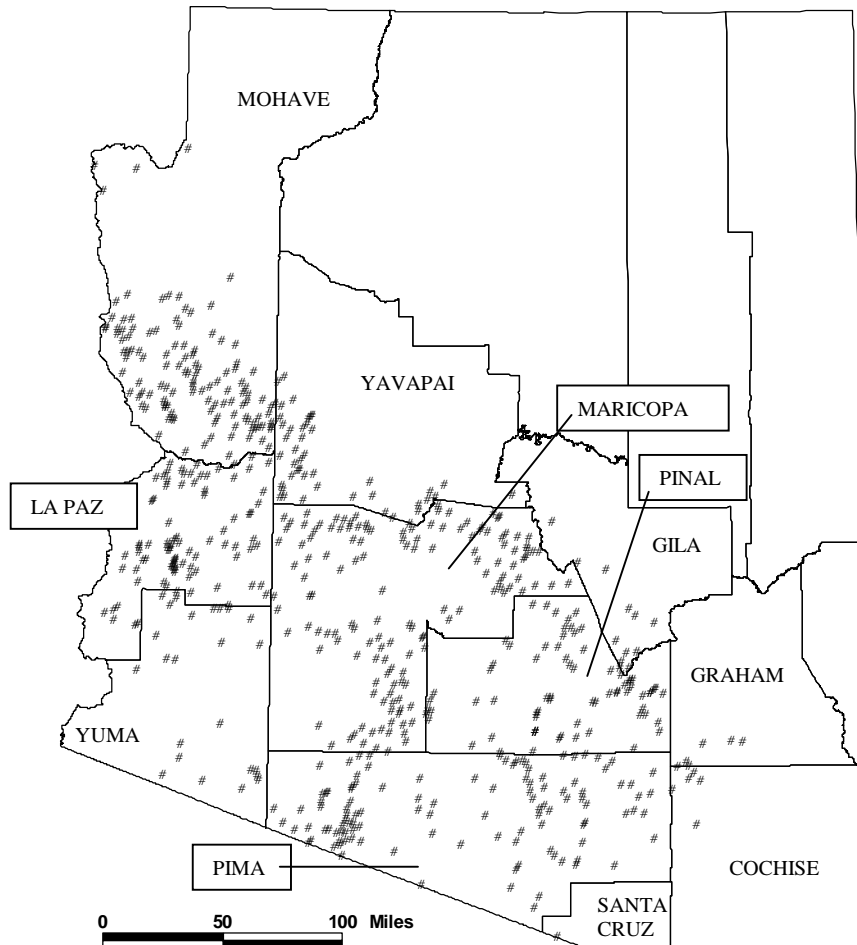


Figure 1. Distribution of the Sonoran Desert population of desert tortoises in Arizona. Each occupied township and range is represented by a separate point. AGFD Heritage Data Management System, 2000.

The Sonoran population of the desert tortoise occurs primarily on rocky slopes and bajadas of Mojave desertscrub and the Arizona Upland and Lower Colorado River Valley subdivisions of Sonoran desertscrub (Barrett 1990; Burge 1979, 1980; deVos et al. 1983; Ortenburger and Ortenburger 1927; Schneider 1981; Vaughan 1984). They most often occur in paloverde-mixed cacti associations (Barrett 1990; Brown 1982; deVos et al. 1983; Ortenburger and Ortenburger 1927; Vaughan 1984) but range from about 510 ft (155 m) in Mojave desertscrub to semidesert grassland and interior chaparral at about 5300 ft (1615 m; AGFD unpubl. data). In the Arizona Upland subdivision, boulders, outcrops, and natural rock cavities are important substrate components of the habitat as sheltersites. Most often, tortoises excavate burrows in deeper soils at the base of boulders and rock outcrops. Caliche caves in incised, cut banks of washes (arroyos) are also used for sheltersites, especially in the Lower Colorado River Valley subdivision. Sheltersites are rarely found in shallow soils. Extensive habitat and sheltersite information is presented in the monitoring plot reports listed in Table 1.

Southward into Sonora and Sinaloa, Mexico, the desert tortoise is restricted to arroyos, slopes, and bajadas in habitats ranging from brittlebush-ironwood and copal-torote associations near sea level to Sinaloan deciduous forests and Madrean evergreen oak woodlands at about 2600 ft (800 m) elevation (Fritts and Jennings 1994; Fritts and Scott 1984; Germano et al. 1994).

#### ECOLOGY OF THE SONORAN DESERT TORTOISE

Adequate shelter is one of the most important habitat features for tortoises in the Sonoran Desert and is important for thermoregulation (Averill-Murray et al., forthcoming a). Tortoises escape temperature extremes by retreating to their burrows, which stay cooler in the summer and warmer in winter than outside temperatures. Tortoises require loose soil in which to excavate burrows below rocks and boulders, but they may also use rock crevices which they may or may not be able to modify. Tortoises occasionally burrow under vegetation instead of rocks. Less often they dig soil burrows on more or less open slopes. Burrows in wash banks range from narrow tunnels to large caliche caves. They will also rest directly under live or dead vegetation without constructing a burrow.

Activity begins in the spring as temperatures warm. If there was sufficient winter rain, tortoises are able to take advantage of spring annuals for forage. Tortoise activity decreases as the season moves into the summer drought in May and June (Averill-Murray et al., forthcoming a). Much more time is spent inactive in burrows where they conserve water and energy. During drought, tortoises retain water in the urinary bladder to dilute excess dietary salts and metabolic wastes (Minnich 1977; Nagy and Medica 1986). However, as drought progresses, weight loss occurs through cutaneous water loss.

Table 1. Desert tortoise populations studied in the Sonoran Desert, Arizona. Estimated density of adults, scaled to one square mile (95% confidence limits). Observed sex ratios: F = female; M = male; U = unsexed; X = carcasses. Type m = monitoring plot (mark-recapture); type t = radio-telemetry study. Land management agency indicated by subscripts.

Locality	Year	Density	F:M:U:X	Type	Citation
Ajo Mtn Drive <sub>ORPI</sub>	1996	75 (21-225)	11:12:6:8	m	26
Arrastra Mtns <sub>BLM</sub>	1987	20 (15-25)	9:6:3:16	m	25
	1997	24 (18-30) <sup>a</sup>	8:5:1:2	m	35
Bonanza Wash <sub>BLM</sub>	1992	---	6:8:3:13	m	30
	1997	27 (16-38) <sup>a</sup>	4:6:3:2	m	35
Eagletail Mtns <sub>BLM</sub>	1987	---	22:12:8:8	m	17
	1990	34 (33-35)	21:8:3:1	m	19
	1991	34 (31-37) <sup>a</sup>	16:9:7:5	m	6
	1992	34 (31-37) <sup>a</sup>	12:10:5:1	m	30
	1993	33 (28-38) <sup>a</sup>	13:10:14:3	m	31
	1994	33 (30-36) <sup>a</sup>	17:11:19:9	m	32
	1998	39 (35-43) <sup>a</sup>	17:14:8:5	m	36
East Bajada <sub>BLM</sub> <sup>b</sup>	1990	---	12:21:12:5	m	21
	1993	67 (51-83) <sup>a</sup>	14:29:3:10	m	31
	1993-94	---	5:8:0	t	9
			14:25:12:14 <sup>c</sup>		
	1997	61 (50-72) <sup>a</sup>	23:20:2:6	m	35
Granite Hills <sub>ASLD</sub>	1990	68 (24-112)	16:16:15:8	m	19
	1991	63 (50-76) <sup>a</sup>	30:19:21:4	m	6
	1992	60 (56-64) <sup>a</sup>	23:22:30:2	m	30
	1993	90 (78-102) <sup>a</sup>	31:24:40:2	m	31
	1994	69 (66-72) <sup>a</sup>	31:29:49:3	m	32
	1998	60 (59-61) <sup>a</sup>	20:16:20:13	m	36
Harcuvar Mtns <sub>BLM</sub>	1988	---	22:33:5:8	m	29
	1991-92	---	6:15:0	t	23
	1993	72 (65-79) <sup>a</sup>	15:29:2:5	m	31
	1997	77 (67-87) <sup>a</sup>	23:27:4:6	m	35
Harquahala Mtns <sub>BLM</sub>	1988	---	9:8:4:4	m	7
	1994	15 (13-17) <sup>a</sup>	10:7:2:0	m	32
Hualapai Foothills <sub>BLM</sub>	1991	---	13:19:5:8	m	6
	1996	52 (44-60) <sup>a</sup>	13:21:2:6	m	34
Little Shipp Wash <sub>ASLD</sub>	1980	---	2:2:2	t	14
		---	18:16:17	m	14
	1990	85 (71-100)	42:26:16:9	m	19
	1991	79 (75-83) <sup>a</sup>	37:30:15:2	m	6
	1991-92	---	6:4:0	t	23
	1992	107 (97-117) <sup>a</sup>	42:34:12:2	m	30
	1993	107 (100-114) <sup>a</sup>	47:36:20:9	m	31
	1994	97 (91-103) <sup>a</sup>	34:27:16:3	m	32
	1998	98 (90-106) <sup>a</sup>	30:18:10:9	m	36
Maricopa Mtns <sub>BLM</sub>	1987	146 (69-223)	24:33:1:65	m	25
	1990	---	6:7:4:54	m	19
	1993-94	---	14:0:0	t	28
Mazatzal Mtns <sub>TNF</sub>	1991-93	---	10:1:0	t	11,13
	1992	150 (83-218)	19:27:5:8	m	10,12
	1995	114 (91-137)	24:25:17:3	m	12

Table 1. Continued.

Locality	Year	Density	F:M:U:X	Type	Citation
New Water Mtns <sub>BLM</sub>	1988	---	8:7:1:2	m	18
	1999	32 (30-35)	9:8:5:3	m	37
Picacho Mtns <sub>ASLD, BLM, BR</sub>	1982-83	---	9:5:0	t	3,24
Quitobaquito Hills <sub>ORPI</sub>	1997	34 (18-60)	16:6:3:1	m	26
Rincon Mtns <sub>SAGU</sub>	1988	---	4:2:2	t	16
Rincons (Javelina) <sub>SAGU</sub>	1996	127 (67-220)	18:29:15:2	m	27
	1997	127 (75-194)	29:29:18:2	m	27
Rincons (Burn) <sub>SAGU</sub>	1996	84 (26-220)	13:12:9:7	m	27
San Pedro Valley <sub>BLM</sub>	1988	---	9:10:1	m	15
	1990-92	---	4:4:0	t	1,2
	1991	---	18:16:9:11	m	6
	1995	125 (103-147) <sup>a</sup>	36:48:6:9	m	33
Sand Tank Mtns <sub>BMGR</sub>	1992	---	19:15:0:31 <sup>d</sup>	m	5
	1994	---	2:5:6:32 <sup>e</sup>	m	4
Santan Mtns <sub>BLM</sub>	1990	---	3:4:1	m	20
	1991	---	16:10:3:3	m	22
Tortolita Mtns <sub>ASLD</sub>	1980-89	---	8:8:2	m	8
	1990-92	---	3:4:0	t	8
Tortilla Mtns <sub>BLM</sub>	1992	---	29:20:3:12	m	30
	1996	97 (82-112) <sup>a</sup>	34:26:12:9	m	34
Twin Peaks <sub>ORPI</sub>	1996	28 (8-73)	9:6:0:0	m	26
Tucson Mtns <sub>SAGU</sub>	1988	---	2:0:1	t	16
Tucson (Panther Peak) <sub>SAGU</sub>	1996	104 (62-166)	26:23:21:12	m	27
	1997	101 (67-142)	34:22:25:?	m	27
West Silverbell Mtns <sub>BLM</sub>	1991	---	39:20:5:11	m	6
	1995	134 (112-156) <sup>a</sup>	40:35:16:8	m	33
Wickenburg Mtns <sub>BLM</sub>	1991	---	5:10:0:2	m	6

Land management agencies: ASLD, Arizona State Land Department; BLM, Bureau of Land Management; BMGR, Barry M. Goldwater Range; BR, Bureau of Reclamation; ORPI, Organ Pipe Cactus National Monument; SAGU, Saguaro National Park; TNF, Tonto National Forest.

<sup>a</sup>Density calculated using tortoises marked from previous and current surveys; therefore, estimates are not independent between surveys.

<sup>b</sup>Population in the Mojave Desert east of the Colorado River but included as part of the Sonoran Desert population in Endangered Species Act decisions by the U.S. Fish and Wildlife Service (FWS 1990).

<sup>c</sup>Total number of tortoises observed.

<sup>d</sup>Combined data from 2, 4-sq.-km plots within 2 km of each other.

<sup>e</sup>Different plots from 1992.

Citations: 1, Bailey (1992); 2, Bailey et al. (1995); 3, Barrett (1990); 4, Dames and Moore, Tucson (1994); 5, Geo-Marine, Inc. (1994); 6, Hart et al. (1992); 7, Holm (1989); 8, Martin (1995); 9, McLuckie et al. (1996); 10, Murray (1993); 11, Murray and Schwalbe (1993); 12, Murray and Schwalbe (1997); 13, Murray et al. (1995, 1996); 14, Schneider (1981); 15, Schnell and Drobka (1988); 16, Shaw and Goldsmith (1988); 17, Shields and Woodman (1987); 18, Shields and Woodman (1988); 19, Shields et al. (1990); 20, SWCA Inc. (1990a); 21, SWCA Inc. (1990b); 22, SWCA Inc. (1992); 23, Trachy and Dickinson (1993); 24, Vaughn (1984); 25, Wirt (1988); 26, Wirt et al. (1999); 27, Wirt (pers. comm., 1999); 28, Wirt and Holm (1997); 29, Woodman and Shields (1988); 30, Woodman et al. (1993); 31, Woodman et al. (1994); 32, Woodman et al. (1995); 33, Woodman et al. (1996); 34, Woodman et al. (1997); 35, Woodman et al. (1998); 36, Woodman et al. (1999); 37, Woodman et al. (2000)

Females begin laying eggs, which are fertilized by sperm stored from the previous summer's mating, just before or during the onset of the summer rains, in late June or early July (Averill-Murray and Klug 2000; Klug and Averill-Murray 1999; Murray et al. 1995). They lay a maximum of 1 clutch of about 6 eggs, but 3-12 eggs in a clutch have been reported. The proportion of females reproducing is related to the amount of recent rainfall and vegetation available for forage (Averill-Murray and Klug 2000). Females usually lay their eggs inside burrows with adequate soil development, and many remain at and defend their nests against predators.

The onset of the summer monsoon season signals the beginning of peak tortoise activity by both sexes, dramatically rising in early August and peaking during August-September (Averill-Murray et al., forthcoming a). With the rains, tortoises are able drink, flush their bladders, rehydrate, and establish positive moisture and energy balances (Minnich 1977; Nagy and Medica 1986; Peterson 1996a,b). Summer is an important feeding time, beginning with dried grasses and other perennials, followed by fresh foliage and annuals. Most social interactions between tortoises, including mating and male-male combat, have been observed during the summer monsoon season. This timing is in part the result of relatively little spring activity in males (Averill-Murray et al., forthcoming a). Adult tortoises typically use a greater proportion of their overall home ranges during summer (Martin 1995).

Some hatchling tortoises emerge in late summer, but some may overwinter underground in the nest before emerging in the spring (Averill-Murray et al., forthcoming b). Hatchlings measure about 46 mm carapace length when they leave the nest and are extremely soft and vulnerable. Little information exists on survivorship of young tortoises, but given adult longevity and their capacity to produce more offspring than necessary to replace mortalities in the population, juvenile survivorship is probably very low (Averill-Murray et al., forthcoming b).

Activity decreases sharply after mid-October, as tortoises withdraw to winter hibernacula, which are similar shelters to those they use during activity seasons (Averill-Murray et al., forthcoming a). Even during the winter, some individuals may bask, move, or even forage on warm winter days, possibly to fight infection and fungus growth. On average females tend to hibernate in shallower shelters than males, exposing them to more variable temperatures (Bailey et al. 1995; Lowe 1990; Martin 1995). As a result, females warm more quickly in the spring and emerge from hibernation earlier than males. Females may terminate hibernation as early as late February, while some males may remain inactive through the entire spring (Bailey 1992; Martin 1995; Vaughan 1984).

Tortoises grow relatively rapidly early in life and reach about 1/2 their maximum size at 5-10 years of age (Murray and Klug 1996). The growth rate tapers off as individuals slowly approach their maximum size. After 10-20 years tortoises reach sexual maturity at about 8.7 inches (220 mm) carapace length. Some growth characteristics vary geographically and by sex (Averill-Murray et al., forthcoming b). The Gila River can be used as a rough line separating tortoise populations that reach different maximum sizes. Tortoises north of the Gila may reach carapace lengths exceeding 11.8 inches (300 mm), while those south of the river may only reach 9.8 inches (250 mm). Males reach

larger sizes than females in some populations but not in others, and females may grow faster than males in some populations.

Like most turtles, the tortoise carapace provides protection against potential predators, contributing to their high survivorship. Mountain lions appear to be the primary natural predator on adult tortoises in the Sonoran Desert, but lions usually have not contributed to elevated rates of mortality in populations studies so far (Averill-Murray et al., forthcoming b).

#### ABUNDANCE AND TRENDS

Through 1999, 18 monitoring plots within the Sonoran desert tortoise population in Arizona had been surveyed at least twice (Table 1). Population density varies greatly among plots, ranging from about 15 to over 150 adult tortoises per square mile and appears to be related to number of available shelter sites (Hart et al. 1992; Howland 1994; Murray and Klug 1996; Woodman et al. 1993, 1994, 1995). Abundance at 17 of these sites appears to be stable or increasing; only 1 (Maricopa Mountains) has been observed to decrease radically in size. Relatively high numbers of carcasses compared to live tortoises have been found at the Arrastra Mountain, Bonanza Wash, and Sand Tank Mountain plots. These cases could represent either accumulated mortality over a number of years, especially for the Arrastra Mountains and Bonanza Wash plots, at which few carcasses have been found in subsequent surveys; a previous short-term decline; or a longer-term decline in progress. While URTD does not seem to be prevalent in populations studied to date, definitive causes of increased mortality at the Maricopa Mountains plot and plots with high numbers of carcasses have not been identified. Potential factors include predation by feral dogs and extended drought. It should be emphasized that determining population trends from only a few points in a narrow window of time is problematic given the long life span of desert tortoises.

How individual populations in the Sonoran Desert interrelate is not well understood (Averill-Murray et al., forthcoming b). Although observations of Sonoran tortoises dispersing far away from rocky ridge habitats are rare, populations, at least theoretically, may depend on occasional cross-valley immigration for genetic interchange and long-term survival. Local tortoise populations receiving high precipitation for 2-3 years may increase, increasing the probability of individuals at or approaching sexual maturity dispersing across the valleys (Morafka 1994). Such tortoises of both sexes have been observed to make relatively long-distance movements (up to three km over a several-week period) away from their normal observed activity centers. They crossed areas of atypical tortoise habitat, including an approximately 1-km wide alluvial fan and steep, boulder-free slopes occupied by few to no resident tortoises (Averill-Murray, pers. obs.).

Most local tortoise populations in the Sonoran Desert appear to be stable at present, but they are increasingly fragmented by urban and agricultural development. Given the fact that individual tortoises live for decades, potential impacts of population isolation may not be seen for many years. The degree to which local populations depend on interchange with other populations for long-term persistence is unknown, as are the effects of dismissing intermountain valleys as “unsuitable” habitat in Sonoran desert tortoise conservation efforts (Averill-Murray et al., forthcoming b).

## THREATS

Most tortoise populations in Arizona's Sonoran Desert appear to be in good health (see references in Table 1). Very few definitive signs of upper respiratory tract disease (URTD) have been recorded, and certainly no epidemic levels of disease have been seen. URTD is often characterized by a serous nasal discharge, swollen eyes, and listless behavior, and the disease is highly contagious (Jacobson et al. 1991). Prevalence of URTD symptoms within Sonoran Desert populations ranges from 0 to 18%, but these figures include many individuals with questionable symptoms (e.g., "whistles" in the breath; see references in Table 1). The East Bajada plot seems to have the most symptomatic individuals, with 11 total cases, but the proportions declined from 18% in 1990 to 4% in both 1993 and 1997.

Virtually every tortoise population studied so far has at least some proportion of tortoises with cutaneous dyskeratosis, although we have observed no detrimental effects to date. This disease may appear on the carapace, plastron, and thickened scales of the forelimbs but usually occurs most severely on the plastron (Jacobson et al. 1994). Affected areas are usually white-gray, have a flaky appearance, and appear to commence at seams between scutes (Jacobson et al. 1994). Only 1% of the tortoises at the Granite Hills plot in 1993 were recorded with cutaneous dyskeratosis, but this increased to 21% in 1994 and 23% in 1998. In the last 5 years (when researchers were more aware of the condition) proportions have ranged from 2-3% at the Harcuvar Mountains and San Pedro Valley plots to 62% at the East Bajada plot.

Even though disease has not played a major role in the Sonoran Desert to date, the threat should not be underestimated due to the catastrophic effects URTD has had on tortoise populations in the Mojave Desert (FWS 1994b). URTD may have been introduced into multiple sites in the Mojave Desert by released pet tortoises (Jacobson 1993). In 1999-2000, 2 separate African spurred tortoises *Geochelone sulcata* were found outside Tucson; both had only wild plant material in their fecal samples, indicating that they had been living in the wild for some time (M. Demlong, pers. comm., 2000). The causative agent(s) of URTD (*Mycoplasma* spp.) have been isolated from several tortoise species (Jacobson et al. 1991).

Urban and agricultural development, roads, off-highway vehicle activity, mining, and grazing by livestock and wild horses and burros may also lead to loss of individual tortoises as well as habitat fragmentation, loss, and degradation. Illegal collection and elevated predation rates may also affect local tortoise populations (AIDTT 1996; AGFD 1996; Barrett and Johnson 1990), and genetic contamination of wild populations and exposure to disease by escaped or released captives pose increasing threats.

The effects of grazing on Sonoran desert tortoises are thought to be relatively minimal compared to Mojave tortoises (Barrett and Johnson 1990). Cattle avoidance of steep, rocky slopes should reduce contact with desert tortoises in most years, but quantitative studies have not been conducted to confirm this expectation. Longer-term, cumulative effects resulting in soil compaction and changes in plant community structure and composition are also unknown, but an increased frequency of

wildfires is associated with invasion by non-native grasses and forbs. Fires affect desert tortoises directly by killing them with lethal heat or low oxygen levels and indirectly by altering their habitats (Brooks et al. 1999).

Population growth in Arizona has been explosive during the last 10-15 years, with Maricopa County the fastest growing county in the nation. Projections are that the Maricopa County-Pima County area will grow by about 71% in the next 25 years (BLM files-Lands Livability Initiative). Millions of acres of public land lie within an hour's drive from this megalopolis. Growth is placing onerous demands for infrastructure such as power lines, power plants, pipelines, landfills, and roads, very often on or adjacent to public lands. Demand is also growing for sand, gravel, and landscape boulders. Granite boulders often provide excellent shelter sites for wild tortoises. Three impacts to desert tortoises are likely from these activities: habitat loss, habitat fragmentation, and direct loss of individuals.

The explosive urban growth results in explosive demands for a variety of recreation, from hiking to off-highway vehicle (OHV) use throughout a mixture of land ownership in Arizona. Over 77% of Arizona residents consider themselves recreational trail users, and depending on the county, OHV users range between 21 and 56% of the adult population (Arizona State Parks 1999). More OHV users use four-wheel drive vehicles, followed by all-terrain vehicles (ATVs) and high clearance two-wheel drive vehicles. A steady increase in ATV sales has occurred since 1995, with the number sold more than doubling between 1995 and 1998. The increase is about 29% annually (Motorcycle Industry Council 1998). The increase in OHV participation is even greater than the population increase. Four-wheel driving, as a percentage of the adult populace, increased from 13% in 1977 to 58% in 1998 (Arizona State Parks 1999).

BLM's Recreation Management Information System (RMIS) corroborates this use in backcountry areas. In the Kingman area for example, the RMIS has tracked a greater than 20% increase in both four-wheel drive use and ATV use between 1994 and 1999 within the range of the Sonoran desert tortoise. This kind of increase in recreational use is likely to contribute to habitat destruction, fragmentation, and more human encounters with tortoises. According to BLM's LAWNET incident reporting system, there were 124 violations of improper vehicle use on or off roads on public land in Arizona in 1998, exclusive of the Arizona Strip. In 1999 there were 123 violations of improper vehicle use on or off roads on public land. An abundance of anecdotal knowledge indicates that contacts between people and wild tortoises usually end to the detriment of tortoises (e.g., collection, handling, vandalism, crushing under vehicle tires, and shooting).

## CONSERVATION AND MANAGEMENT LEGISLATION PERTINENT TO DESERT TORTOISES

Agencies in Arizona have used a variety of regulatory and management tools to reduce threats to the Sonoran population of the desert tortoise, the most important of which are listed here. This section of the report includes a review of major legislation and authorities. The following section discusses agency-specific regulations, policies, and management.

## ENDANGERED SPECIES ACT

The purposes of the ESA include conserving endangered and threatened species and the ecosystems upon which they depend. All federal agencies are required to use their authorities to conserve threatened and endangered species. Following the FWS ruling that the Sonoran Desert population of the tortoise did not warrant listing under the ESA (FWS 1991), the population was considered a Category 2 candidate for listing. Category 2 candidates were species for which the FWS had information indicating listing might be appropriate, but sufficient information was lacking to support a proposed rule. The Category 2 list has since been discontinued, so the Sonoran population currently has no status under the ESA (FWS 1996). However, the FWS informally considers the Sonoran population a species of concern and continues to monitor its status to determine if designation as a candidate for listing (species for which information is sufficient to support preparation of a proposed rule to list the species) is warranted. Protection of other listed species, such as the Sonoran pronghorn *Antilocapra americana sonoriensis* and the cactus ferruginous pygmy-owl *Glaucidium brasilianum cactorum*, provides some protection to desert tortoise habitats. The Lower Colorado River Multi-Species Conservation Program may also provide some benefits to desert tortoises in Arizona.

## NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) and its implementing regulations require all federal agencies to evaluate the consequences to the natural and human environment of all major federal actions. The term "major federal actions" has been interpreted to include nearly all federal actions. Each of the primary federal land and resource managing agencies have further defined the NEPA process within their own implementing regulations (found within appropriate sections of the Code of Federal Regulations).

NEPA typically requires the lead federal agency to conduct the evaluation, including a determination of the appropriate level of documentation. Most projects with the potential to affect desert tortoise habitats will require an Environmental Assessment. Should the Environmental Assessment conclude that there is a potential for *significant* adverse impact, then an Environmental Impact Statement is required.

NEPA encourages and, at some levels, mandates public and agency participation in the evaluation process. Federal, state, tribal, and local agencies may each submit comments on actions and

recommendations to avoid, reduce, or mitigate adverse impacts. It is through this process that AGFD works to protect the Sonoran desert tortoise on federally managed lands.

#### WILDERNESS ACT

Under this legislation, the Secretaries of Interior and Agriculture were directed to review all roadless areas over 5,000 acres (2,000 ha) for possible inclusion into the National Wilderness System. Final designations of wilderness would be made by Congress. Wilderness legislation in 1984 and 1990 resulted in the designation of large acreage of wilderness on Forest Service, BLM, and National Wildlife Refuge lands in Arizona. The 1990 legislation was especially important for the tortoise, because it included primarily BLM lands and wildlife refuges. Wilderness was designated at Cabeza Prieta, Kofa, Imperial, and Havasu national wildlife refuges and many desert mountain ranges on BLM lands, such as the Maricopa Mountains, Sierra Estrella, Swansea, and Gibraltar Mountains (Fig. 2). Wilderness designations prohibit or limit many human activities that could result in mortality of tortoises or habitat destruction. For example, use of motorized vehicles and equipment, mining, utility corridor construction, and other surface disturbing activities are prohibited or strictly controlled in wilderness areas.

#### OTHER AUTHORITIES

Other mechanisms for protecting desert tortoise habitat include the Sikes Act, which provides for cooperation among state agencies and the departments of Defense and Interior in planning, development, and maintenance of fish and wildlife resources on military installations, and section 404 of the Clean Water Act, which requires permits for dredge and fill activities in waters of the United States and adjacent wetlands, including desert washes. Also relevant are the Land and Water Conservation Fund, which authorizes acquisition of lands to enhance outdoor recreation and protection of threatened and endangered species, and the Department of Interior's Field Coordinating Committee, which annually funds projects along the U.S.-Mexico border and have the potential to benefit desert tortoises, as well.

#### Sikes Act

The Sikes Act provides for cooperative management of natural resources on military installations. It requires completion and implementation of Integrated Natural Resources Management Plans on military lands. The 3 primary agencies involved in preparation, review, and approval of the plans are: the applicable Department of Defense agency, AGFD, and FWS. Integrated Natural Resource Management Plans will normally contain explicit projects and procedures to protect and enhance populations of priority species, as identified in the plan. Most plans for military installations in Arizona contain provisions for protection and management of Sonoran desert tortoise populations.

#### Clean Water Act

Section 404 of the Clean Water Act establishes procedures for review and permitting of actions which may result in fill or dredging of "waters of the United States." Since the definition of "waters of the United States" has been interpreted to include dry xeric washes that can be very important to species such as the Sonoran desert tortoise, this provides another important tool for natural resource

management agencies. Often it is this law that triggers NEPA and causes NEPA evaluation of otherwise non-federal actions.

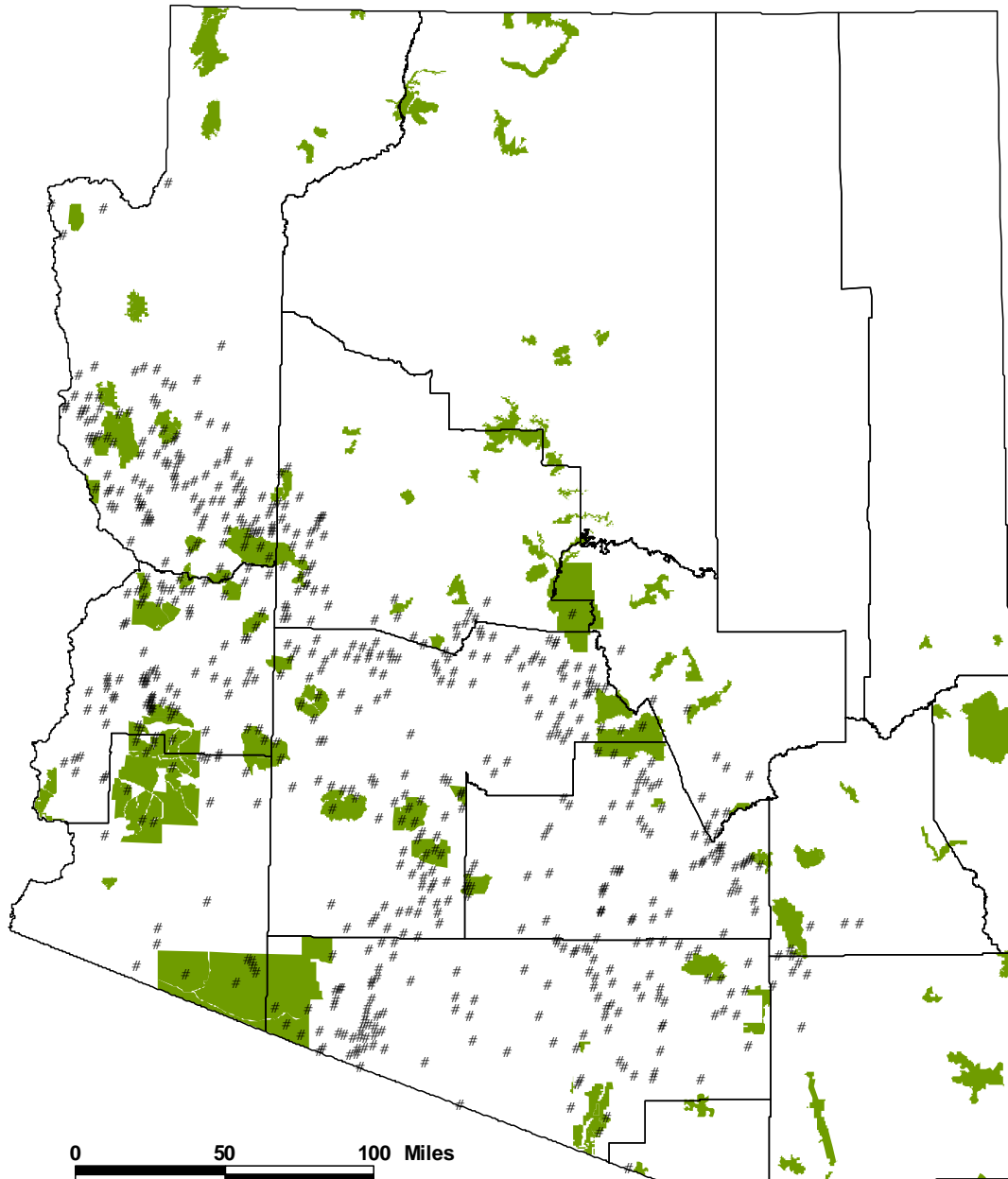


Figure 2. Wilderness areas in Arizona. AGFD Heritage Data Management System, 2000.

## CURRENT MANAGEMENT IN THE SONORAN DESERT, ARIZONA

Under the following agency headings, we discuss regulations, policies, and management for desert tortoises particular to each agency.

## ARIZONA GAME AND FISH DEPARTMENT

Both Mojave and Sonoran desert tortoises in Arizona are included as a single entry on the AGFD list of *Wildlife of Special Concern in Arizona* (AGFD in prep.). The list of wildlife of special concern has no regulatory mandate vested in law. The list identifies wildlife of concern to the AGFD because their occurrence in Arizona is, or may be, in jeopardy and they merit special management consideration by state and federal agencies. The State of Arizona currently has no laws specific to designation or protection of endangered species or their habitats and has no state environmental policy legislation.

The impact of illegal take, through poaching (i.e. vandalistic shooting or unlawful capture), on tortoise populations is unknown in Arizona, though the effects of shooting are well known for California (Berry 1986c). Collecting for commercial and other purposes appeared to reduce some populations near Tucson significantly after the 1950s (C. Lowe pers. obs.), and periodic collecting still occurs (M Tuegel pers. comm., 2000).

Prior to January 1, 1988, the Arizona Game and Fish Commission's rules allowed live possession of one lawfully captured tortoise per person. Effective January 1, 1988, the Commission prohibited the take of desert tortoises from the wild, except under special (i.e. scientific or educational) collecting permits. The Commission also prohibits the sale of tortoises, their import or export, and the release of captives within the state. Commission rules provide for disposition of lawfully possessed tortoises by gift to another person in Arizona, or as directed by the Arizona Game and Fish Department. No provisions have been made to permit or otherwise identify those tortoises that were in lawful possession prior to January 1, 1988. Enforcement of the state closure on take may not be possible except when the actual taking of a tortoise from the wild is observed. The remoteness of much tortoise habitat makes enforcement difficult at best. In addition, these laws and rules are poorly known to much of the public and substantial education efforts are needed.

Commercial use of tortoises does not appear to be a significant threat in Arizona (J. Bidle pers. comm., 1998), probably because pet store owners are more aware of the pertinent state laws than is the general public. AGFD investigations of the black market pet trade over the past several years have revealed very little tortoise activity. Even so, tortoises are still occasionally offered to, sold to, and sold by pet dealers and private individuals in Arizona.

## ARIZONA STATE LAND DEPARTMENT

Arizona State Trust land comprises 13% of Arizona. The 9.5 million acres (3.84 million ha) of trust land are managed to derive revenues for trust beneficiaries including educational, health, and penal institutions. Scattered state trust land is included within the range of the Sonoran desert tortoise (Fig.

3), but significant blocks of tortoise habitat on state land occur west of the Upper Burro Creek, Arrastra Mountain, and Tres Alamos wilderness areas in Yavapai County and from the Tortolita to the Tortilla mountains in Pinal County. Two tortoise populations on state lands have been monitored during the last decade (Table 1). An estimated 60 adult tortoises occur on the 1-square-mile Granite Hills plot (Pinal Co.), a reduction from an estimated 90 adults in 1993, and approximately 98 adult tortoises occur on the Little Shipp Wash plot (Yavapai Co.) of the same size. Both these populations are moderate-to-high density populations relative to others studied in Arizona (Table 1).

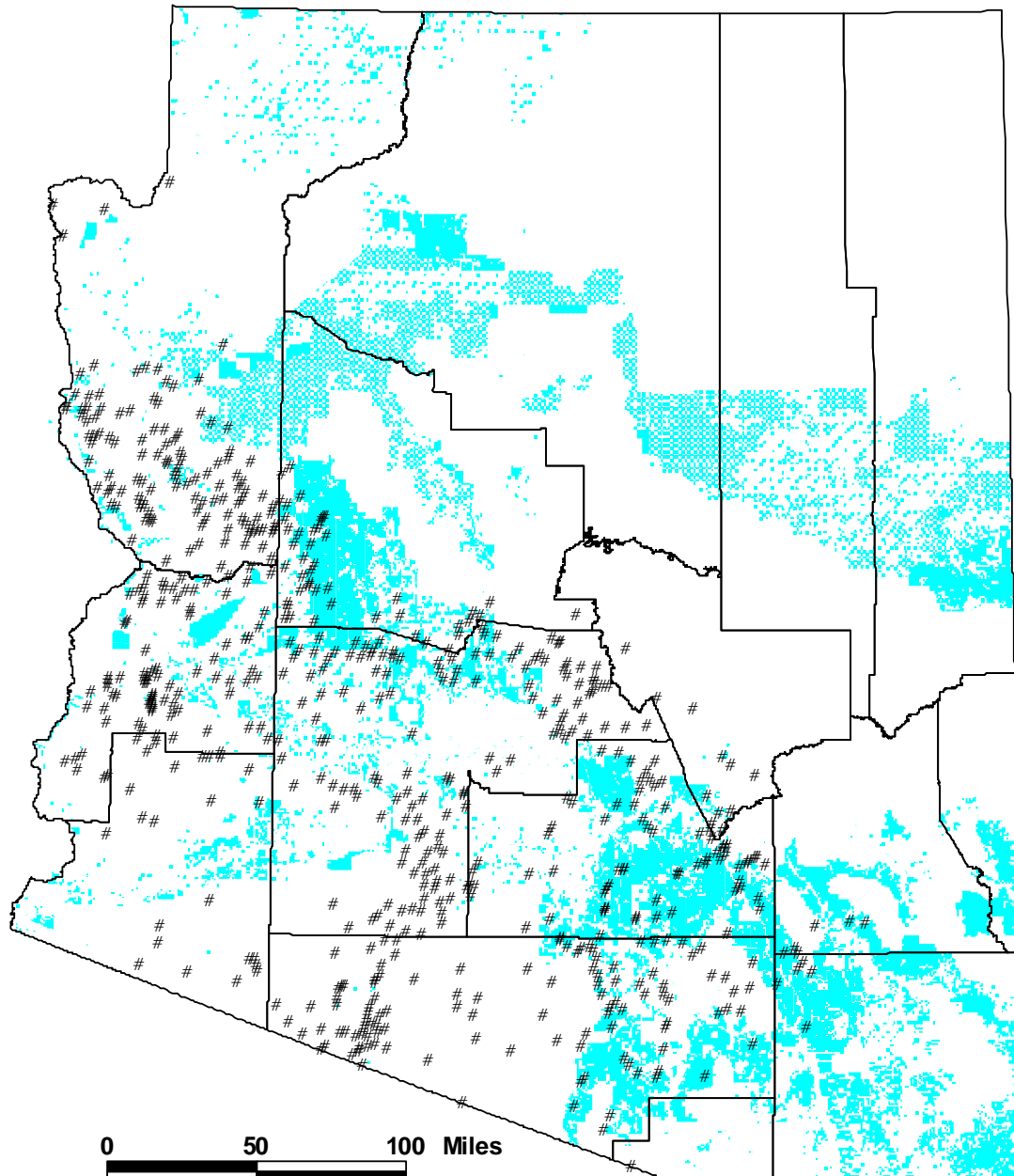


Figure 3. Arizona State Trust lands within the range of the Sonoran desert tortoise. AGFD Heritage Data Management System, 2000.

While the Arizona State Land Department has no broad management practices directed toward the desert tortoise, it often considers the needs of the desert tortoise in specific projects through coordination with AGFD. For instance, as part of the review process for a range improvement project, a copy of the range improvement application is forwarded to AGFD for comment. If AGFD finds the proposed project is within the range of the desert tortoise, it may recommend specific mitigation measures to lessen project impacts to the tortoise. These recommendations may be used in the formulation of Special Conditions that are attached to the range improvement permit. AGFD is also allowed an opportunity to comment on projects relating to urban planning, sales, exchanges, rights-of-way, and commercial leases. AGFD's recommendations are also considered for these kinds of projects, but the State Land Department is not obligated, in their mission to maximize the economic return of the lands, to implement AGFD's recommendations in either case.

#### BUREAU OF LAND MANAGEMENT

BLM manages the majority of desert tortoise habitat in Arizona (Fig. 4). The 1994 AIDTT MOU stated that the AIDTT would function as BLM's desert tortoise technical committee, providing advice and technical expertise to BLM regarding desert tortoise issues on public land. Prior and subsequent to this MOU, BLM has managed for desert tortoises through a variety of mechanisms.

The Federal Land Policy Management Act of 1976 directed BLM to manage public lands for multiple use and sustained yield. Wildlife is identified as one of the major uses of public lands. The Sikes Act authorizes BLM to develop and implement plans in cooperation with state wildlife agencies and the Department of Defense for the development and protection of wildlife habitat. BLM develops a variety of tiered plans for management of multiple uses on public land (including, to varying degrees, management for desert tortoises). The primary planning level is the Resource Management Plan (RMP). RMPs are regional or landscape-level in nature, cover large land areas often greater than 1,000,000 acres (405,000 ha) in size, and often coincide with the boundary of a BLM field office. An RMP allocates uses and protection of resources. To implement land use decisions under specific RMPs, BLM develops activity plans. Activity plans include Habitat Management Plans, Wilderness Management Plans, Interdisciplinary Management Plans, and others.

#### Desert Tortoise Habitat Categorization and Compensation

BLM prepared a report in 1987 (BLM 1987) which addressed the current status of the desert tortoise and its habitat on public lands and contained recommendations for actions needed to improve management of that habitat. A range-wide management plan (Spang et al. 1988) and a strategy specific to BLM lands in Arizona (BLM 1990) were developed to implement those recommendations. The Rangewide Plan groups desert tortoise habitat into 3 categories according to the following 4 criteria: (1) importance of the habitat to maintaining viable populations, (2) resolvability of conflicts, (3) desert tortoise density, and (4) population status (stable, increasing, or decreasing). BLM's goal is to maintain viable desert tortoise populations in Category I and II habitats and to limit population declines to the extent possible in Category III habitats. BLM adopted the categorization and goals in its RMPs and RMP amendments. The distribution of habitat categories is illustrated in Figure 5, and the amount of public land in each habitat category is shown in Table 2.

Because desert tortoise habitat has been categorized within the boundaries of each field office, other lands not managed by BLM were included within many of the polygons drawn to depict habitat (Table 3). Other lands include National Wildlife Refuge, military, National Park Service, tribal, private, county, state, state and county parks, state wildlife areas, and Forest Service. Some large areas within field office boundaries were not categorized, as no public land was involved or intermingled (e.g., Forest Service and National Wildlife Refuges).

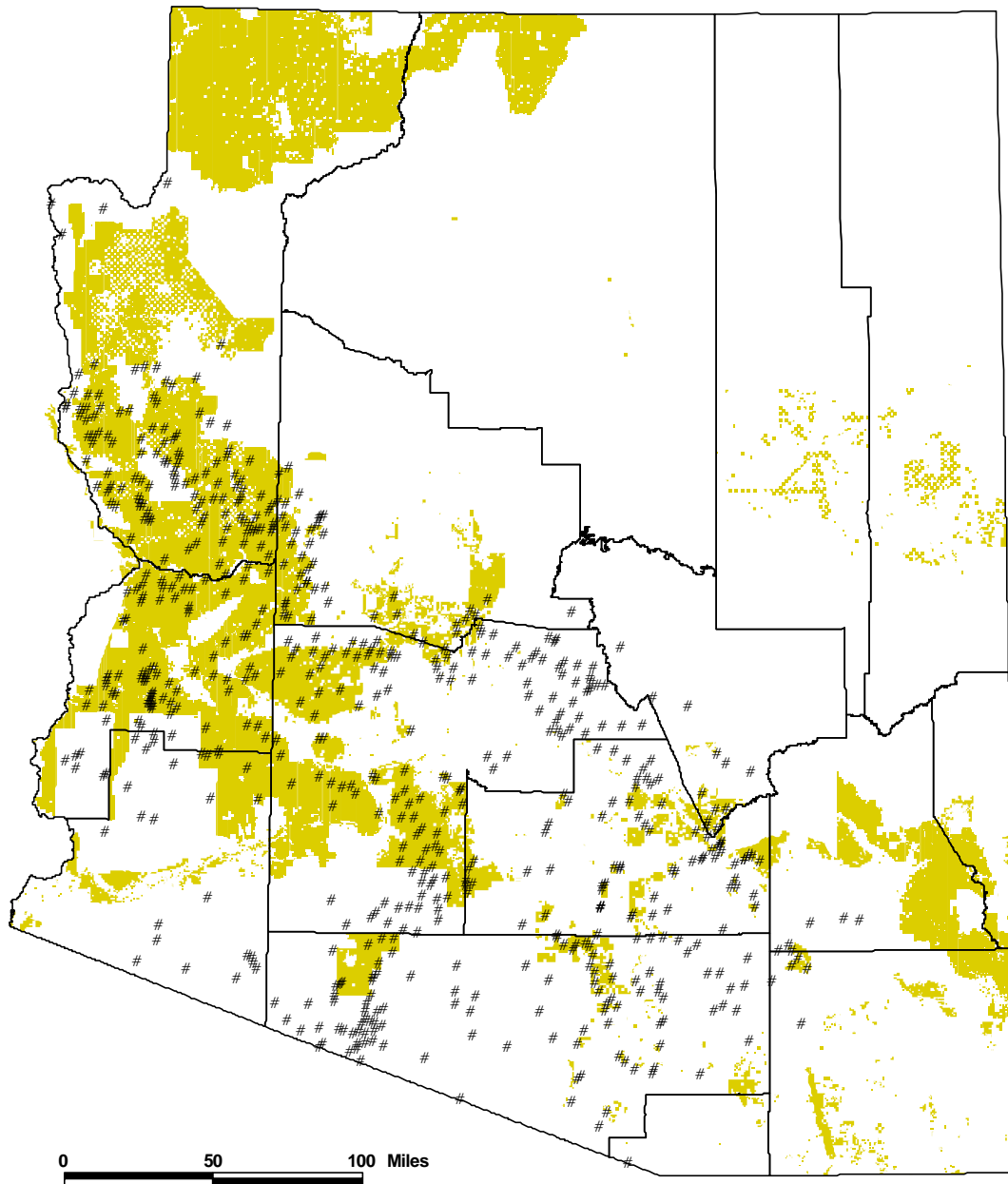


Figure 4. Bureau of Land Management lands within the range of the Sonoran desert tortoise. AGFD Heritage Data Management System, 2000.

Table 2. Sonoran desert tortoise habitat on land managed by BLM, by field office (acres).

Habitat Category	Phoenix	Kingman	Safford	Yuma	Tucson	Lake Havasu	Total
I	278,663	64,032	0	0	19,913	104,695	467,303
II	965,900	317,169	8,553	229,393	148,604	275,712	1,945,331
III	145,847	924,928	14,387	129,717	135,491	595,291	1,945,661
Total	1,390,410	1,306,129	22,940	359,110	304,008	975,698	4,358,295

Table 3. Land ownership of Sonoran desert tortoise habitat in categorized areas (acres).

Habitat Category	BLM	Other Federal	Non-Federal	Total	Percent Federal
I	467,303	215,132	41,334	723,769	94
II	1,945,331	204,523	450,380	2,600,234	83
III	1,945,661	206,519	1,655,429	3,807,609	57
Total	4,358,295	626,174	2,147,143	7,131,612	70

Most tortoise plots that have been monitored in Arizona occur within Category I or II habitat. The most current estimates of tortoise densities range from 15 to 134 adult tortoises per square mile among plots in Category I habitat (Arrastra Mountains, Bonanza Wash, East Bajada, Harcuvar Mountains, Harquahala Mountains, and West Silverbell Mountains; Table 1). The only significant, documented population decline in Arizona's Sonoran Desert occurred at the Maricopa Mountains plot, also in Category I habitat, where density was reduced from 146 to only a handful of adult tortoises in the late 1980's (Table 1). The Eagletail Mountains, Hualapai Foothills, New Water Mountains, San Pedro Valley, Santan Mountains, Tortilla Mountains, and Wickenburg Mountains plots occur within Category II habitat, and densities range from 32 to 125 adult tortoises on those for which estimates are available (Table 1). The Granite Hills plot on state land and Sand Tank Mountains plots on Barry M. Goldwater Range lands also fall within Category II habitat. Finally, population monitoring has occurred within Category III habitat on the Little Shipp Wash plot (state land) and in the Tucson Mountains (Saguaro National Park) (Table 1).

The Rangewide Plan identifies management actions needed to implement the goals of each habitat category, which address environmental education, off-road vehicle use, energy and mineral development, livestock use, lands and realty actions, and other activities which may affect desert tortoises. Included is a provision to compensate for residual impacts to desert tortoises after other mitigation measures are incorporated into proposed actions. BLM follows a "no-net-loss" policy of desert tortoise habitat relative to impacts and land-use decisions, but lands received as compensation for detrimental impacts to tortoises are themselves subject to impacts by future activities unless protected by wilderness or Area of Critical Environmental Concern designation.

In late 1991, the interagency Desert Tortoise Management Oversight Group approved a compensation policy for the desert tortoise. Arizona BLM put that policy into practice in 1992. In

March 1999 BLM modified its policy on compensation for residual impacts due to projects in tortoise habitat. Compensation, if needed, is determined through a formula that includes varying rates in the 3 categories of desert tortoise habitat. Compensation and the formula are discussed in the *Management Plan for the Sonoran Desert Population of the Desert Tortoise in Arizona* (AIDTT 1996). Modifications in BLM's policy concentrate on handling funding and other details, not the use or determination of compensation. BLM's careful considerations of projects and use of compensation have resulted in project relocation or modification, protective tortoise fencing, culverts for crossing, outright acquisition, and funds used for acquisition or other tortoise conservation activities.

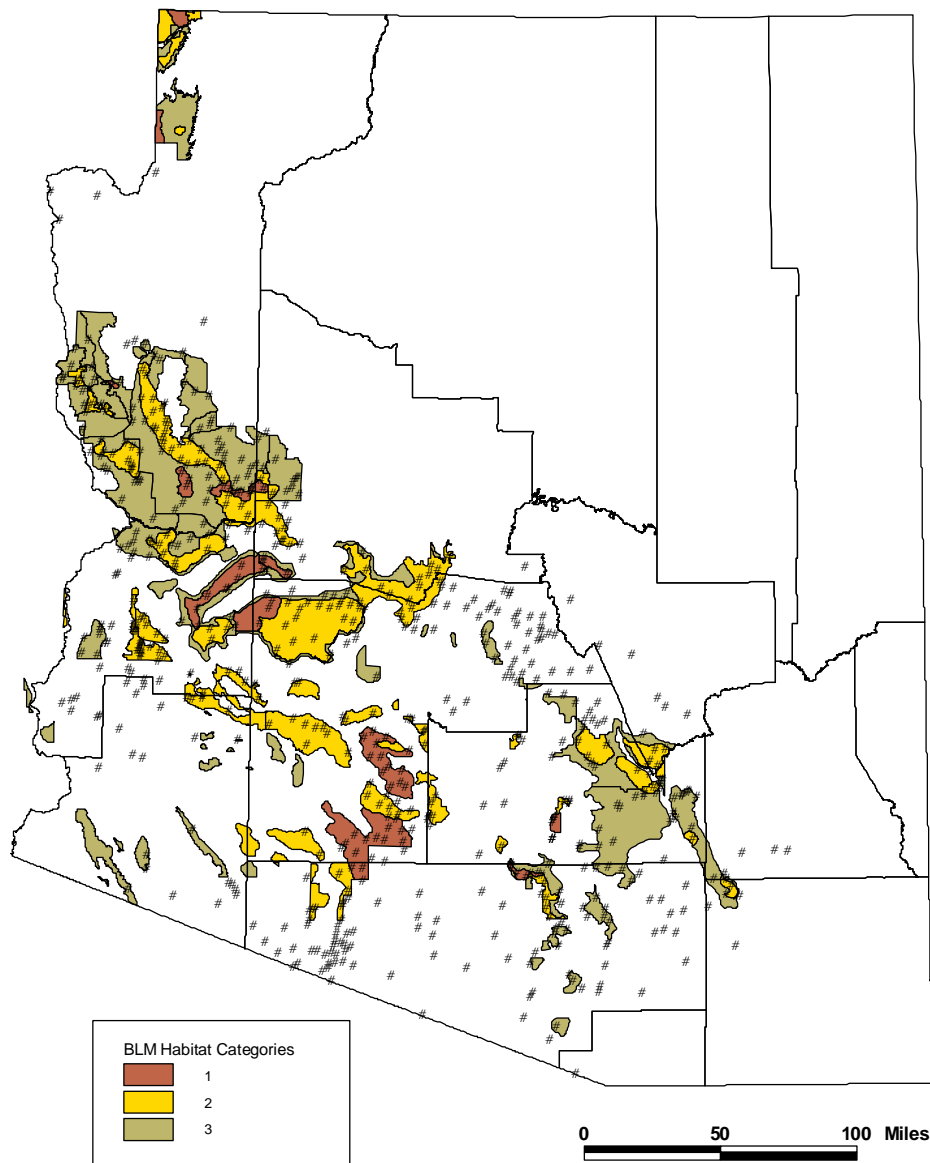


Figure 5. Bureau of Land Management habitat categories for desert tortoises in Arizona. AGFD Heritage Data Management System, 2000.

### Resource Management Planning

Arizona BLM has also completed RMP Amendments (with the exception of the Phoenix RMP) or new land use plans that incorporated objectives, actions, and policy concerning habitat goals, categories, and expectations called for in the BLM Rangewide Plan and Arizona Implementation Strategy. RMPs or amendments that apply to desert tortoise habitat include Kingman, Yuma (includes most of the Lake Havasu Field office), Lower Gila South and Lower Gila amendments (includes Phoenix Field Office and parts of the Tucson, Kingman, Yuma, and Lake Havasu field offices, Barry Goldwater Range), Phoenix (includes Phoenix Field Office and parts of the Tucson and Safford field offices), and Safford (includes part of the Tucson Field Office). Each RMP formalized boundaries of desert tortoise habitat categories and established goals for the categories. Each RMP also identified lands for acquisition or disposal, which is discussed later. RMPs set the direction for grazing and recreation uses, including off-highway vehicle use of roads and routes on public land.

For example, approximately 520,220 acres (210,526 ha) of public lands in the Yuma District RMP area were designated for management as Category I, II, or III desert tortoise habitat. Management levels appropriate to each category goal were applied to habitat area consistent with BLM's Desert Tortoise Rangewide Plan. The Yuma District RMP was also amended to manage approximately 84,420 acres (34,164 ha) of Category I and II tortoise habitat as priority wildlife habitat. For the purposes of the RMP, activities authorized in priority wildlife habitat would either have to be compatible or made compatible with mitigation. The Yuma District RMP also designated the Crossman Peak Natural Scenic Area to protect cultural and unique wildlife habitat. The natural scenic area is approximately 26,080 acres (10,554 ha) and includes both Category II and III desert tortoise habitat. Desert tortoises within the Lake Havasu Field Office received additional protection, because they occur within a desert bighorn sheep year-long use area. Seasonal and some year-long restrictions on land uses (vehicle closure) are being implemented in the Bill Williams, Buckskin, Mohave Mountains, and Aubrey Hills. All of these mountain ranges contains either Category II or III tortoise habitat.

RMPs also guide several uses that fluctuate with demand, including mining, oil and gas leasing, and mineral materials. Oil and gas leases are offered in some areas periodically, but there has not been an application for permit to drill in 10 years. Hard rock mining demand is not experiencing any great increases either in claims or development, but 27,000 mining claims exist on public land in Arizona, a majority of which are within the range of the Sonoran desert tortoise. Recent changes in mining regulations were made that required payment of annual fees rather than having to do a minimum amount of assessment work in the field on mining claims each year. Mining claims rarely lead to development, but the sheer number of claims leads to a likelihood that tortoises will be impacted when development does occur. Operations are managed under Surface Management Regulations and require an approved Mining Plan of Operations and NEPA review if they are greater than 5 acres in size. New regulations may be implemented by the year 2001 which would remove the acreage threshold. Requests for mineral material sales (sand, gravel, rock) are experiencing increasing demand, particularly near the Phoenix-Tucson megalopolis. Sales of these materials are discretionary and are granted to avoid impacts to desert tortoises. For example, several requests for sales of

landscape boulders have been denied by BLM managers in recent years in occupied desert tortoise habitat, as boulders are crucial to tortoise use and habitat quality.

Wild burros occur in several areas inhabited by the Sonoran desert tortoise, including the Black Mountains, Alamo Lake, Big Sandy, Harquahala, Little Harquahala, Painted Rock, Lake Pleasant, Cibola-Trigo, and Havasu herd areas (Table 4). Although these areas are extensive, they do not all contain desert tortoise habitat. For instance, the Black Mountains area and Cibola-Trigo areas are largely unoccupied by tortoises. BLM is undertaking an action plan to reach appropriate management levels (AML), establishing and reaching a sustainable, “thriving natural ecological balance,” by Fiscal Year 2003. AMLs are set in the RMP planning process. The majority of the herd management areas will already be at AML by 2002.

Table 4. Wild Burro Herd Areas within the range of the Sonoran desert tortoise (acres).

Herd Area Name	BLM	Other	Total	Field Office
Alamo	287,785	53,259	341,044	Kingman, Lake Havasu
Big Sandy	191,975	51,918	243,893	Kingman
Black Mountains	590,563	503,611	1,094,174	Kingman
Harquahala	117,469	8,786	126,255	Phoenix
Cibola-Trigo	280,877	764,656	1,045,533	Yuma
Havasú	308,856	141,766	450,622	Lake Havasu
Lake Pleasant	62,582	40,888	103,470	Phoenix
Little Harquahala	51,961	13,932	65,893	Lake Havasu
Painted Rock	31,282	7,455	38,737	Phoenix

The Arizona Standards for Rangeland Health and Guidelines for Grazing Administration were completed on April 28, 1997, through a statewide plan amendment and environmental assessment. The standards and guidelines are being used in grazing allotment evaluations over the next several years. There are 3 standards: upland health, riparian health, and desired plant community. Meeting or making adjustments to attain standards for upland health and desired plant communities will be valuable for the desert tortoise and its habitat. In the next 3 years, BLM will be evaluating a large number of grazing allotments for re-issuance of 10-year permit renewals. The standards mentioned above will be evaluated during that process.

As described in the 1990 status summary on the Sonoran desert tortoise (Barrett and Johnson 1990), livestock grazing may not be a significant issue in much Sonoran desert tortoise habitat in Arizona. Because livestock tend to take the paths of least resistance and avoid steep slopes and long distances from water, many mountain ranges inhabited by the Sonoran desert tortoise receive little livestock use. In contrast, the Mojave population of the desert tortoise, largely inhabiting desert valley floors and bajadas, is much more subject to potential competition with livestock for forage or trampling of tortoises or their burrows. Where significant exceptions occur to the above generalization about

livestock and Sonoran desert tortoises, BLM will make changes where warranted, based on the above-mentioned permit renewal process and standards evaluations.

In 1994 Arizona BLM adopted a policy on ephemeral livestock grazing authorizations, ensuring that sufficient forage was available before authorization and that forage would remain at the end of the livestock use period. Special conditions were included for desert tortoises and other special status species, such that after April 1 initial authorizations would be made for no more than 30 days. Field checks would be made by an interdisciplinary team to ensure sufficient forage exists. Extensions of authorizations would be made for no greater than 30 days at a time, with field checks before subsequent extensions. This was a significant protective change that ensured forage for other animals, such as desert tortoises, and also ensured that perennial plants would not be damaged due to insufficient ephemeral growth.

Additionally, BLM announced, on January 10, 2000, that a new OHV Management Strategy will be developed to meet increasing OHV recreational demands, which is occurring throughout the west. In one area experiencing the onslaught of urban weekend escapees, the Bradshaw Mountains foothills, BLM has begun working with other agencies and the public to plan for vehicle routes and other trails. The ability to carry out management priorities and enforce protections is restricted by personnel availability. Patrolling public lands to ensure compliance with prescriptions and to monitor whether objectives are being met are both largely lacking.

#### Land Designation

Areas of Critical Environmental Concern (ACEC) have been designated for some areas often requiring special management or resource protection (Fig. 6). Of the 51 ACECs that have been designated through BLM's planning processes in Arizona, 16 include some Sonoran desert tortoise habitat (Table 5). Some ACECs, such as Poachie and McCracken were designated primarily because of high value and protection needs for desert tortoise habitat. Others were primarily designated because of other values, and the fact that portions of the areas are inhabited by tortoises was an added benefit. Protections for most ACECs concern minimizing surface-disturbing activities, limiting vehicular travel, camping, fire use, mineral activities, or even grazing seasons. Compatible uses and incompatible uses, and objectives for management are established for each ACEC.

In the intervening years since the 1991 Fish and Wildlife Service 12-month petition finding that the Sonoran population of the desert tortoise did not warrant listing under the ESA (FWS 1991), BLM has completed interdisciplinary wilderness planning on 28 of the 47 wilderness areas the agency manages in Arizona. The planning and implementation has resulted in relief from access issues, reclaiming damaged areas, reclaiming old vehicle ways and routes, establishing campfire and camping policies to avoid resource impacts, establishing livestock grazing use objectives with respect to desired vegetation, setting objectives for wildlife habitat including the desert tortoise, and setting prescriptions for wildfire. Inholdings within wilderness boundaries continue to be acquired on a willing-seller basis to remove additional wilderness management conflicts. These actions are particularly important because of the large amount of desert tortoise habitat managed as wilderness.

Wilderness designation has protected nearly 850,000 acres (344,000 ha) of Sonoran desert tortoise habitat on public lands administered by BLM in Arizona (Table 6, Fig. 2).

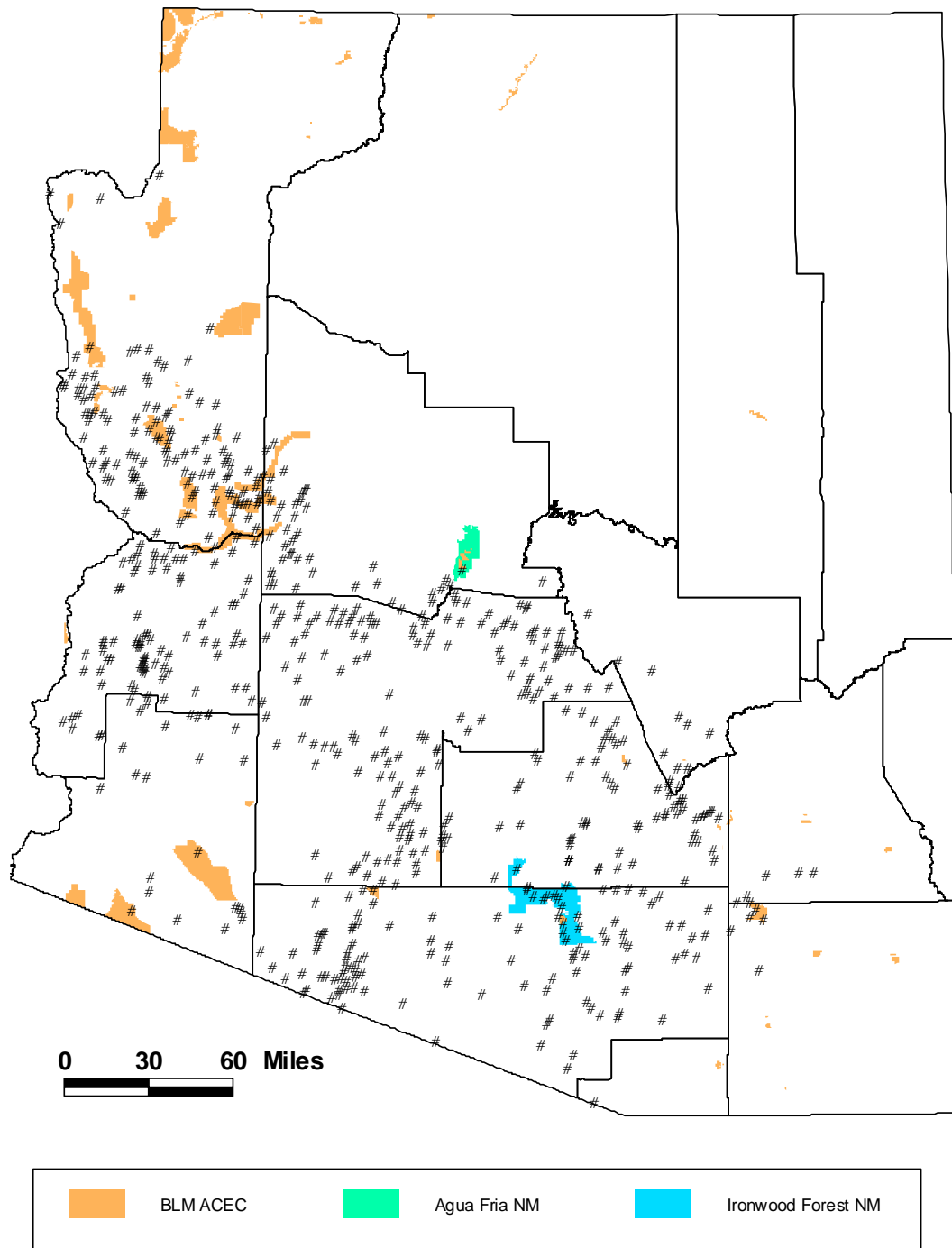


Figure 6. BLM Areas of Critical Environmental Concern and 2 national monuments within the range of the Sonoran desert tortoise. AGFD Heritage Data Management System, 2000.

Table 5. BLM Areas of Critical Environmental Concern with Sonoran desert tortoise habitat.

ACEC Name	Acres	Resource Values	RMP Name	Field Office
Coffeepot Botanical	9,600	Endangered Plant	Lower Gila South	Phoenix
Larry Canyon	80	Riparian Deciduous Forest	Phoenix	Phoenix
Perry Mesa	9,440	Cultural	Phoenix	Phoenix
Mohawk Mountain and Dunes	132,000	Rare Plants, Crucial Bighorn Sheep Habitat	Lower Gila South-Goldwater Amendment	Phoenix, Yuma
Aubrey Peak Bighorn Sheep Habitat	3,460	Bighorn Sheep Habitat, Scenic	Kingman	Kingman
Burro Creek Riparian & Cultural	22,682	Riparian, Cultural, T&E Habitat	Kingman	Kingman
Poachie Desert Tortoise Habitat	32,752	Desert Tortoise Habitat, Scenic	Kingman	Kingman
McCracken Desert Tortoise Habitat	21,740	Desert Tortoise Habitat, Scenic	Kingman	Kingman
Black Mountains Ecosystem	114,242	Bighorn Sheep Habitat, Plants, Scenic, Cultural	Kingman	Kingman
Three Rivers Riparian	32,043	Riparian, T&E Species	Kingman	Kingman Lake Havasu
White-Margined Penstemon Reserve	17,489	White-Margined Penstemon Habitat	Kingman	Kingman
Swamp Springs/Hot Springs	10,838	Riparian, T&E Species, Cultural	Safford	Safford, Tucson
Bear Springs Badlands	2,927	Paleontological, Scenic	Safford	Safford
Tinajas Altas	60,500	Scenic, Cultural	Lower Gila South-Goldwater Amendment	Yuma
Waterman Mountains	1,960	Endangered Plant	Phoenix	Tucson
White Canyon	300	Scenic, Wildlife, Cultural	Phoenix	Tucson

Table 6. Sonoran desert tortoise habitat in BLM Wilderness, by field office (acres).

Habitat Category	Phoenix	Kingman	Safford	Yuma	Tucson	Lake Havasu	Total
I	125,164	15,746	0	0	0	25,039	165,949
II	185,162	143,636	989	63,629	4,745	29,331	427,492
III	2,306	183,668	2,574	10,539	8,460	48,868	256,415
Total	312,632	343,050	3,563	74,168	13,205	103,238	849,856

Since BLM lands cover such a large proportion of tortoise habitat in the state, tortoise populations and habitat overlap with most other land management agencies, often interspersed with state and private lands. BLM's RMPs identify lands for acquisition or disposal, usually through land exchanges, which could divest BLM of scattered, unmanageable lands with lesser resource values, while helping to "block-up" other areas with higher resource values, that would be more manageable under BLM ownership. Several BLM RMPs identify important desert tortoise habitat for acquisition and, some areas with Category III (usually because of complex land ownership patterns) tortoise habitat for disposal. For example, the Hualapai Mountain land exchange was completed in early 1999. Approximately 70,000 acres (28,300 ha) of land were acquired in the McCracken and Hualapai Mountains southeast of Kingman for approximately 60,000 acres (24,300 ha) of scattered lands north and south of Kingman. Important Category I and II habitats were "blocked-up" in areas of public ownership, while some Category III and II habitats were traded and will become available for development. There was a net gain of 8,724 acres (3530 ha) of Category I and II habitat. The overall impact to the desert tortoise should be beneficial, as much more habitat of better quality was gained than lost, and BLM will have better management capability. The McCracken Mountains parcels are now managed as part of the McCracken ACEC for the desert tortoise.

On January 11, 2000, President Clinton issued a proclamation designating the Agua Fria National Monument, which lies east of Interstate 17, north of Black Canyon City, Arizona (Fig. 6). Approximately 7,000 acres (2800 ha) of Category II desert tortoise habitat are found at the south end of the monument. Following a resolution by the Pima County Board of Supervisors in March 2000 to Interior Secretary Bruce Babbitt and Secretary Babbitt's recommendation on May 31, President Clinton issued a proclamation on June 9, 2000, designating the Ironwood Forest National Monument. This monument lies west-northwest of Tucson (Fig. 6), and includes approximately 17,223 acres (6970 ha) of Category I, 43,670 acres (17,673 ha) of Category II, and 71,701 acres (29,016 ha) of Category III desert tortoise habitat. The Ironwood Forest National Monument also includes the Waterman Mountains ACEC. Both monuments are managed under the Phoenix RMP and the BLM Director's interim management policy, protecting the cultural and natural resources until a specific management plan is prepared. Protections include limitations on surface disturbance from damage to soils and vegetation, no new roads or rights of ways, and increased patrolling to ensure existing protections are heeded.

Despite strides made in the last decade toward conservation of the Sonoran desert tortoise and the ecosystem upon which it depends, several challenges remain. Comprehensive land use planning, resulting in RMPs, is largely 10-15 years old. BLM (and other agencies, for that matter) has an urgent need to update its planning and organization to meet these urban/recreational growth challenges and continue to conserve the Sonoran desert tortoise on public lands.

#### NATIONAL PARK SERVICE

The National Park Service (NPS) was established in 1916 with the passage of the Organic Act. This Act gave NPS the authority to manage and protect national parks, monuments, and reservations, and it provides a greater degree of protection than many other public lands. NPS is mandated by law to "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Broad resource management goals include reducing ground disturbance, developing inventory and monitoring programs, assessing and mitigating resource disturbance, and developing environmental restoration and research programs. All wildlife inhabiting Arizona NPS areas is protected, and wildlife possession or removal is a vigorously prosecuted crime. Enforcement personnel from other federal and state agencies operate cooperatively to detect infractions. The National Park System includes parks, monuments, historic sites, and recreation areas, and each unit of NPS is administered according to its own enabling legislation. Thus, permissible activities and uses of Park Service lands can vary from one unit to another. However, all units are ultimately tied to the purposes stated in the Organic Act and must be managed according to its directives. The Act's carefully chosen language gives NPS strong resource protection powers, and the Act has proven invaluable in resolving conflicts between land use and preservation, as well as in making management decisions that help protect the nation's natural resources.

Even though NPS makes no special provision for conservation of the Sonoran desert tortoise, preservation of ecosystems instead of single species is mandated by NPS policy, in expectation that intact ecosystems will support an appropriate species spectrum of self-regulating populations. This policy was based on the "Leopold Committee" report (Leopold 1963), which recommended that "the biotic associations within each park be maintained, or where necessary re-created, as nearly as possible in the condition that prevailed when the area was first visited by white man."

The "Robbins Committee" report (Advisory Committee to the National Park Service on Research 1963) built upon the Leopold Committee concept into one of ecosystem self regulation, mentioned above: maintain ecosystems and species will care for themselves. Chase (1987) reviews these concepts and is critical of NPS for adopting them simplistically. That no ecosystem is large enough or isolated enough to escape indirect human impact may invalidate the NPS's ecosystem policy and cause it to be dropped.

Current NPS policy permits, encourages, and fosters research on its lands, provided the investigator can demonstrate that such research is in the NPS's interest and/or that it cannot be effectively accomplished outside the park. The advantages of conducting tortoise research on NPS lands are clear (grazing control, known history, freedom from gross disturbance, etc.). However, NPS areas preferentially

attract visitors who are attracted to nature. Bennett et al. (1987) demonstrated that NPS visitors were more likely to remove small cacti illegally than were visitors to federal lands administered by other agencies. Whether tortoises are similarly removed is unknown, but NPS lands are viewed by some members of the public as good places to release tortoises that they picked up (illegally) elsewhere or got tired of as pets. One specific case occurred in 1995 when U.S. Customs prevented a man from releasing in Organ Pipe Cactus National Monument (ORPI) 2 desert tortoises from Mexico. Another tortoise was left at the ORPI Visitor Center by a camper who had picked it up “near Yuma ... or Barstow ... somewhere out there.”

Within the National Park System, ORPI, Saguaro National Park (SAGU), and Lake Mead National Recreation Area (LMNRA) contain tortoise populations protected (in theory) from adverse human disturbance (Fig. 7). Total geographical extent of ORPI and SAGU is 414,014 acres (167,546 ha). Within this area, approximately 25% is estimated to be suitable tortoise habitat. Fewer tortoises occur on LMNRA.

#### Organ Pipe Cactus National Monument

Tortoises at ORPI are distributed through all expected upland habitats, as well as extending down the bajadas in arroyo cut banks, where they use caliche caves as shelter sites. Habitat ranges from relatively lush, dense, diverse expressions of the Arizona Upland Subdivision on the east (e.g., Ajo Mountains) to open, xeric Lower Colorado River Subdivision in valley floors and western mountain ranges (e.g. Agua Dulce and Growler Mountains). Tortoises in the very xeric western side of the Monument occur at densities somewhat lower than the more mesic eastern side (Wirt et al. 1999). Population densities range from 75 adults per square mile at the Ajo Mountain Drive plot on the east side of ORPI, to 28 per square mile at the Twin Peaks plot, to 34 per square mile at the Quitobaquito Hills plot in the southwest part of the monument (Table 1). Tortoise habitat at ORPI extends into the adjacent lands of Cabeza Prieta NWR, The Tohono O’odham Indian Reservation, the BLM (Category II habitat), and Mexico.

ORPI is managed as designated wilderness, and livestock grazing is excluded within the Monument. The Monument receives recreational use, although recreation is minimal during months of highest tortoise activity. ORPI experiences very high levels of illicit activity, including drug smuggling and movement of illegal immigrants. Some aspects of these activities are likely detrimental to desert tortoises, including off-road driving, high-speed driving, woodcutting, setting fires, and trampling native vegetation. These activities may also result in impacts from interdiction activities of Park Rangers, U.S. Border patrol, and the Drug Enforcement Agency (DEA).

C. Lowe and P. Rosen assessed reptile populations at ORPI (Rosen and Lowe 1996). They indicated that tortoise populations were at reasonable levels and that no special conservation measures were required. Currently, lizards and some snakes are included as part of a long-term ecological monitoring program. More recently, Wirt et al. (1999) found that desert tortoise populations still appeared to be stable; relatively few carcasses were found on newly established long-term monitoring plots (Table 1). Continued monitoring of these plots depends on availability of funds and staff. ORPI has no plans to re-survey the plots in the foreseeable future.

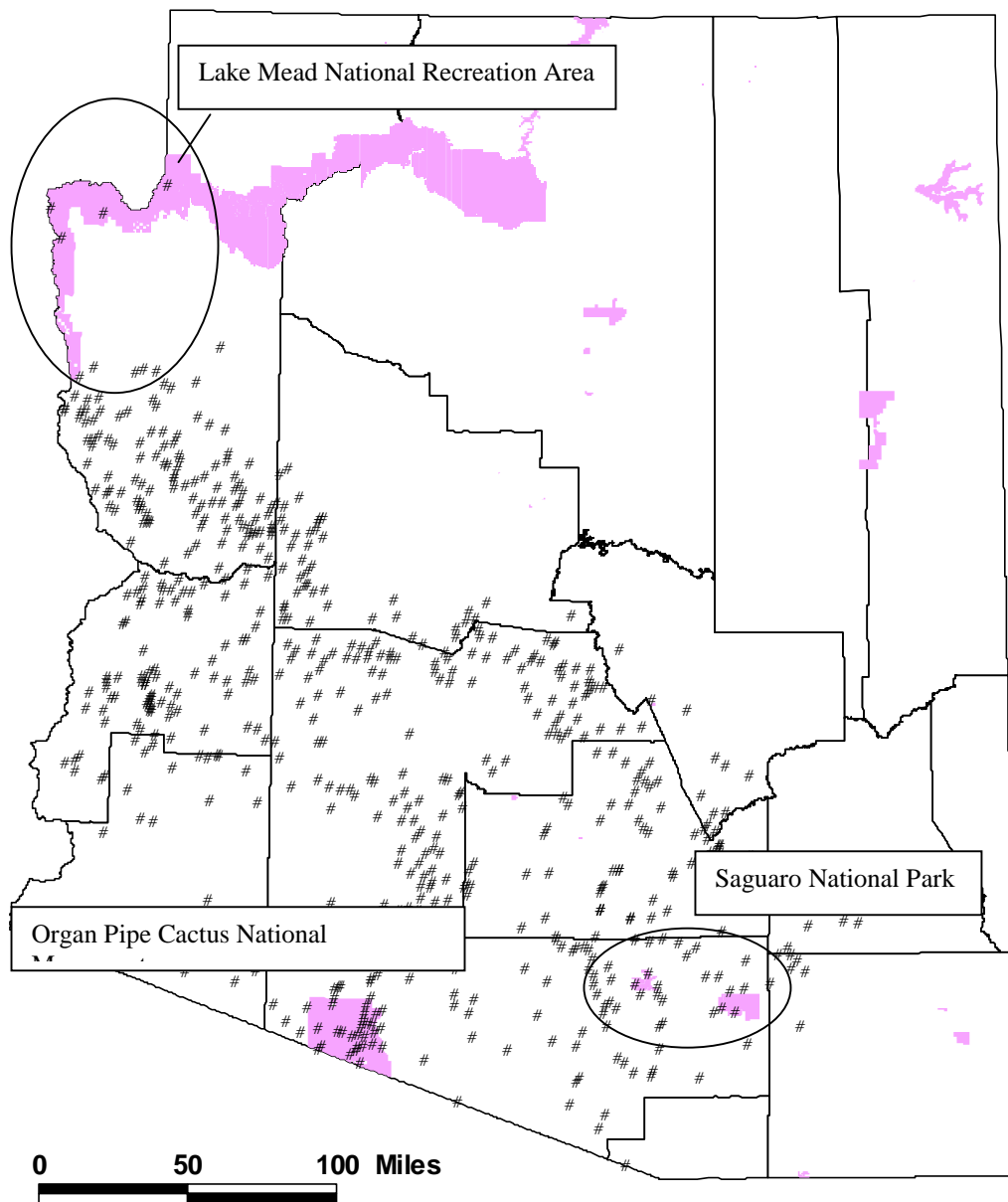


Figure 7. National Park Service lands within the range of the Sonoran desert tortoise. AGFD Heritage Data Management System, 2000.

#### Saguaro National Park

Sonoran desert tortoises occur in both districts of SAGU in Sonoran desertscrub habitats, generally below 4500 ft (1372 m; approximately 45,000 acres [18,000 ha] between the 2 districts). In the 67,000-acre (27,000 ha) Rincon Mountain District of the park (including a recent expansion containing desertscrub habitat), tortoises have also been documented regularly up to 4700 ft (1433 m) at a site in a transitional zone between semi-desert grassland and juniper-oak woodlands

(Robichaux and Wirt 1996). Below 4500 ft (1372 m), this district provides excellent, virtually contiguous tortoise habitat, and in places supports dense tortoise populations. For example, densities reach 127 adults per square mile at the Javelina Campground plot (Table 1). Tortoise habitat adjacent to this district occurs on the Coronado National Forest and private lands, including a resort community currently in development on the southern boundary.

Tortoises are distributed more patchily throughout the 24,000-acre (9700 ha) Tucson Mountain District of the park, and they occur in greatest concentrations on the mountain bajadas, where it is believed greater soil accumulations facilitate burrow excavation (Robichaux and Wirt 1996). Tortoise densities exceed 100 adults per square mile at the Panther Peak plot (Table 1). With the recent development of much of this bajada habitat in the Tucson Mountains, habitat remaining in the park is increasingly important for the long-term viability of this local population. Tortoise habitat adjacent to this district occurs on private, BLM, state, and county lands, particularly Tucson Mountain Park. The entire area has been categorized by BLM as Category III tortoise habitat.

In the past decade, several studies have been conducted on tortoises in SAGU. From 1988-89, the NPS funded a suite of studies to determine the effects of urbanization on park resources, including desert tortoise populations. This research concluded that park tortoises within a kilometer of the boundary where it abutted urban environments were at risk from roadkill, collecting, and other urban hazards (Goldsmith 1990). Park staff are currently following this study up with additional telemetry studies of tortoise populations along the park boundary. A study of tortoise diet and nutrition in the Tucson Mountains was initiated in 1992 and is currently in progress. One of the more interesting aspects of this work is a goal to discern the importance of exotic plant species in desert tortoise diets, both in terms of selection and nutrition (Tom Van Devender, pers. comm., 1999). From 1995-97, the NPS funded an overall inventory and monitoring study of desert tortoises at SAGU, including telemetry studies of high-elevation tortoise populations. Preliminary reports on this study have established relative abundance data for the park and recommended protocols for on-going monitoring (Robichaux and Wirt 1996; Wirt et al. 1998). Finally, the Biological Resources Division of the USGS is currently conducting a long-term study on the effects of fire on desert tortoises and desert vegetation at the site of a 1994 wildfire in Sonoran desertscrub habitat in the Rincon Mountain District.

Saguaro National Park has also developed interpretive and educational materials on the desert tortoise. These materials include:

- 1) a park flyer (site bulletin) that summarizes Sonoran desert tortoise natural history and the regulations applying to them;
- 2) an illustrated pamphlet that provides more in-depth information on desert tortoise (both Mojave and Sonoran) natural history and guidance for what to do if you encounter one; and
- 3) desert tortoise educational kits, which include a trunk full of props (including a freeze-dried desert tortoise) and a school (kindergarten through high school) curriculum, for use by educators.

Lake Mead National Recreation Area

LMNRA's mission and master management plan is outlined in the park's Resource Management Plan (RMP). Broad goals of this plan focus on reducing and eliminating ground disturbance, developing resource inventories and monitoring programs, assessing and mitigating resource disturbance, and developing restoration and research programs. Projects identified in the RMP that relate specifically to desert tortoises include the following: 1) desert tortoise inventory, distribution, and density research, much of which has been completed over the last 3 years as part of a project funded through the Park Service's Natural Resource Preservation Program; 2) continued involvement in the development and execution of the Habitat Conservation Plan of Clark County, Nevada; 3) studies, in conjunction with other agencies, of the feasibility of desert tortoise translocation; and 4) studies of tortoise population response to wildfire, a project which at the present time is unfunded.

LMNRA is in the unusual situation of being home to both Mojave and Sonoran populations of desert tortoise. Although the Mojave population is federally protected under the Endangered Species Act and the Sonoran population is not, park policy has been to ignore this delineation and treat both populations with equal regard. Many of the threats faced by LMNRA's Mojave population, including illegal off-road vehicle use, poaching, and the presence of feral burros, also threaten the Sonoran population. In addition, tortoises on the Arizona portion of the park are threatened by extremely low population densities. The Clark County Habitat Conservation Plan has served both as a source of funding and as a mechanism by which multiple agencies can coordinate tortoise management in southern Nevada. With no similar mechanism for management of Sonoran tortoises, the park is interested in developing means by which research, monitoring, and habitat protection efforts can be expanded for tortoises on the Arizona portion of the park. To that end, the park is seeking opportunities for cooperation and collaboration with other agencies and researchers to any extent possible.

Surveys initiated in 1995 indicate that tortoises occur in low densities across much of that portion of LMNRA occurring within the range of the Sonoran Desert population. Tortoises have been found at LMNRA in a variety of habitat types including Mojave desertscrub (creosote-bursage association), Joshua tree woodland, semi-succulent scrubland, and areas of gypsum outcropping. Occupied terrain includes bajadas, washes, and relatively steep hills and desert mountain slopes. Other than Category III BLM habitat at the southern end of the Recreation Area, tortoises are not known to occur on adjacent lands on the south and east side of the Colorado River. LMNRA contains several paved and dirt roads approved for public use, but large areas are inaccessible by road and consequently not heavily used by humans.

**FISH AND WILDLIFE SERVICE REFUGES**

The U.S. Fish and Wildlife Service is responsible for conserving, enhancing, and protecting fish and wildlife and their habitats for the continuing benefit of people through federal programs relating to wild birds, endangered species, selected marine mammals, inland sport fisheries, and specific fishery and wildlife research activities (U.S. Department of the Interior 1984). The National Wildlife Refuge System plays an important role in the mission of the Service. The National Wildlife Refuge System

Improvement Act (1997) provides an “Organic Act” and mission statement for the Refuge System. The mission of the Refuge System is “to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.” Refuges preserve and protect natural ecosystems, including tortoise habitat. Tortoises on some refuges are also protected under the Arizona Desert Wilderness Act of November 1990. The Act established 1,343,487 acres (543,692 ha) of wilderness, including about 355,000 acres (143,500 ha) of tortoise habitat, on 4 Arizona refuges (Havasu, Imperial, Kofa, and Cabeza Prieta).

Desert tortoises occur primarily on 3 National Wildlife Refuges (NWRs) in Arizona (Buenos Aires, Cabeza Prieta, and Kofa; Fig. 8), but abundance has not been estimated for tortoise populations on any of the refuges. Limited tortoise habitat also occurs on Cibola, Imperial, and Havasu NWRs, adjacent to BLM Category III habitat. Tortoises occur along the western side of Buenos Aires NWR in the Las Guijas and San Luis mountains. These areas are adjacent to Arizona State lands and BLM Category III tortoise habitat, as well as probable contiguous habitat on the Nogales Ranger District of the Coronado National Forest. Tortoises occur on desert mountain ranges throughout Cabeza Prieta NWR, with suitable habitat connecting to the Barry M. Goldwater Air Force Range and Organ Pipe Cactus National Monument. Cabeza Prieta NWR has focused primarily on the preservation of desert bighorn sheep and Sonoran pronghorn. However, the refuge will continue to protect, inventory, monitor, and manage for desert tortoises. Tortoises also occur on desert mountain ranges throughout Kofa NWR, with suitable habitat connecting to adjacent habitat on the Yuma Proving Ground and BLM Category II habitat.

Off-road vehicle use is prohibited on all 6 refuges that have tortoises. Prescribed burning is permitted on Buenos Aires NWR, but each burning proposal must be reviewed and approved to insure non-impact to tortoise populations. Domestic livestock generally cannot be grazed on the six refuges. However, on Buenos Aires National Wildlife Refuge, 6 horses used for monitoring masked bobwhite, are allowed to graze one pasture that does not contain tortoise habitat under a special use permit.

The U.S. Border Patrol uses administrative roads on Cabeza Prieta NWR, but these roads are not open to public use. Off-road driving by the Border Patrol may cause mortality to desert tortoises, but these activities have been decreasing recently. In addition, the U.S. Air Force and Marine Corps use the airspace above the Refuge for training. Loud noises (sonic booms) had little impact on desert tortoises in experimental studies, but their effects still need to be studied on wild individuals (Bowles et al. 1999a,b).

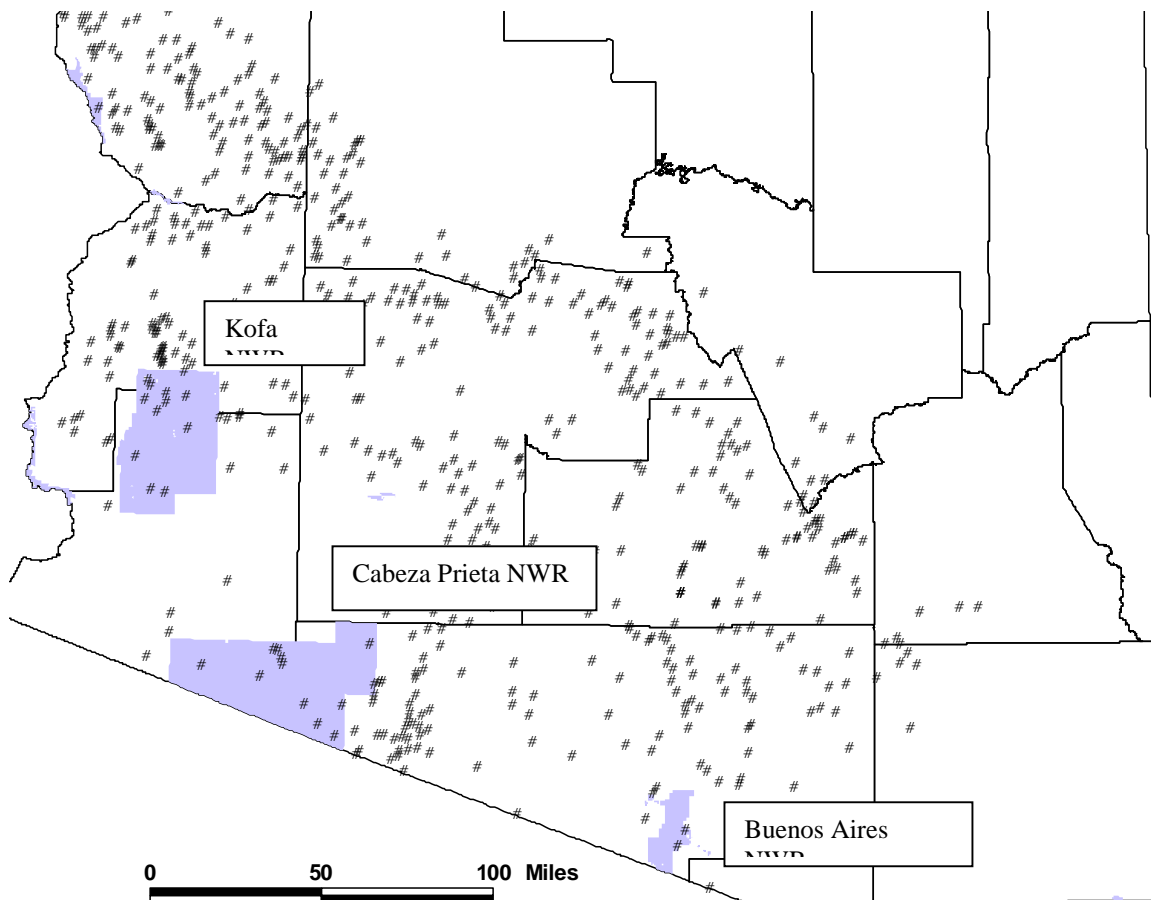


Figure 8. National Wildlife Refuges within the range of the Sonoran desert tortoise. AGFD Heritage Data Management System, 2000.

#### DEPARTMENT OF DEFENSE

Figure 9 highlights Department of Defense lands containing Sonoran desert tortoises. Luke Air Force Base and the Marine Corps Air Station – Yuma jointly manage tortoise habitat on the Barry M. Goldwater Range. The Department of the Army manages Yuma Proving Grounds, which includes tortoise habitat in mountain ranges surrounding Kofa National Wildlife Refuge. The Arizona Army National Guard manages desert tortoise habitat at the Florence Military Reservation.

#### Yuma Proving Ground

This U.S. Army installation is used primarily for testing of military munitions and material. Occasionally, military training and non-military testing activities occur (U.S. Army Yuma Proving Ground, 1998). The installation is about 840,000 acres (340,000 ha) in size and is located in southwestern Arizona near the Colorado River. The nearest metropolitan area is the city of Yuma, approximately 23 mi (37 km) southwest of the installation.

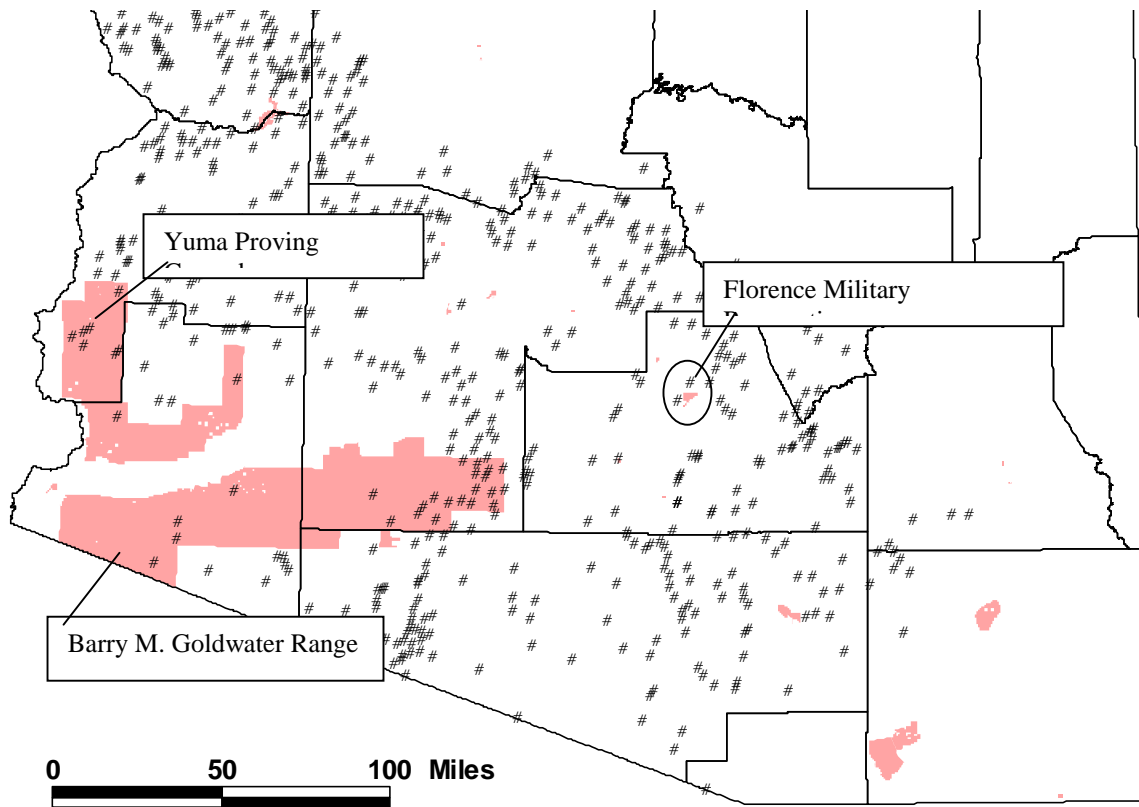


Figure 9. Department of Defense lands within the range of the Sonoran desert tortoise. AGFD Heritage Data Management System, 2000.

Northwestern and eastern arms of the installation are considered to have some habitat for the desert tortoise. These areas are generally contiguous with BLM Category III lands outside the installation. AGFD conducted extensive field and literature searches and documented tortoises at 4 locations on the installation – Trigo Mountains/Crazy Woman Wash, Tank Mountains, Palomas Mountains, and Chocolate Mountains (Palmer 1986). An extensive survey for tortoises and habitat was conducted in 1991 (LeDuc 1992). Only one tortoise carapace has been observed over the past 5 years by the installation biologist (J. Kerns pers. comm., 2000). That sighting was of a scavenged shell near a water development on the south side of the Tank Mountains. Other recent surveys have reported potential habitats but no physical sign (scat, shells, etc.).

Most of the installation is closed to public access year round. Approximately 133,000 acres (54,000 ha) are open to hunting for about 6 months each year (September-February). Most military activities occur on lands or in airspace to the south of potential desert tortoise habitats. As such, the potential for “uncontrolled” population or habitat impacts is very low. Natural resources are managed in accordance with the *Yuma Proving Ground Integrated Natural Resources Management Plan* (U.S. Army Yuma Proving Ground 1997), which incorporates the *Management Plan for the Sonoran*

*Desert Population of the Desert Tortoise in Arizona* (1996) by reference. Natural and cultural resource field crews are briefed and requested to report any tortoise sightings to the Conservation Program Office. Records of observations are submitted to the AGFD Heritage Database.

#### Barry M. Goldwater Range

More extensive habitat occurs on portions of the Barry M. Goldwater Range (BMGR), especially on the eastern half, where Category I habitat includes the Saucedo Mountains and the southern portion of the Sand Tank Mountains. Category II habitat includes the Aguila, portions of the Growler and Sand Tank mountains, and the Crater Range. The western half of BMGR includes Category III habitat along the Gila, Butler, Tinajas Altas, Copper, Mohawk, and Granite mountains, as well as the Wellton Hills. Tortoise habitat extends along mountain ranges into adjacent lands primarily managed by BLM, Cabeza Prieta NWR, and the Tohono O'odham Indian Reservation. Dozens of 3-mile sign transects have been surveyed in various mountain ranges across BMGR, but standard monitoring plots have only been surveyed in the Sand Tank Mountains, where substantial numbers of carcasses have been found (Table 1). Tortoise densities appear to decline from east to west as elevation decreases and the climate gets hotter and drier; annual rainfall ranges from about 9 to 3 inches from east to west. Surveys are conducted on all lands that it manages to ensure compliance with NEPA when projects are proposed.

The Military Lands Withdrawal Act of 1999 (PL 106-65) transferred jurisdiction over lands on BMGR to the U.S. Air Force on the east side and to the Marine Corps on the west side. This law also ended the inclusion of Cabeza Prieta National Wildlife Refuge within BMGR. BLM retains responsibility for natural and cultural resource management for the withdrawn lands until November 6, 2001. The Air Force and Marines are working to have a management plan in place by that date. PL 106-65 also directed the Air Force to relinquish 4 parcels of land. Of these, only the parcel known as Area A, which contains part of the Sand Tank Mountains, is likely to contain desert tortoises and their habitat. Under the terms of P.L. 106-65, the ultimate disposition of these lands will not be known for some time, since the law also directs the Department of Interior to study the management and protection of the lands. This study, which is also to consider whether the lands would be better managed by the federal government or through conveyance to another appropriate entity, is currently under way.

Activities within BMGR are primarily aerial, with surface disturbance by military activities usually located in valleys outside most tortoise habitat. The Marine Corps conducts some ground maneuvers on the western half of BMGR, but mostly in valleys. The vast majority (>90%) of the range is undisturbed by military activity. Limited public access is allowed along designated routes. The U.S. Border Patrol may conduct its patrols on- or off-road.

#### Florence Military Reservation

The Arizona Army National Guard's Florence Military Reservation (FMR) consists of 25,752 acres (10,421 ha) of lands under the varied administration of the Arizona Army National Guard, Arizona State Land Department, and BLM (Department of Emergency and Military Affairs [DEMA] 1997) and is categorized by BLM as Category III desert tortoise habitat. FMR is used primarily as an artillery training range, but public access is restricted only during posted live-fire exercises (DEMA 1997). Cattle grazing and recreational use, including hunting, camping, and OHV use, also occur on FMR.

Surveys conducted in 1997 found tortoises distributed throughout much of the area, primarily in or near xeroriparian washes with incised banks. Several rocky hills occur in or near the artillery impact area but have not been surveyed extensively for tortoises. Tortoise habitat extends to adjacent Category III state land to the north and Category II and III state and BLM land to the east.

#### FOREST SERVICE

The Forest Service's Southwestern Region sensitive species list was revised, effective July 21, 1999. The Sonoran desert tortoise is on the list for the Coronado, Prescott, and Tonto national forests (Fig. 10), which means it should be considered in all biological evaluations for activities and projects proposed within its habitat.

#### Coronado National Forest

Approximately 250,000 acres (101,000 ha) of potential tortoise habitat occurs on the Coronado National Forest (NF) in desertscrub and desert grassland biomes, with the largest proportion occurring in the Santa Catalina Ecosystem Management Area (Table 7). About 11,400 acres (4600 ha) are currently considered to be in unsatisfactory range condition, but new analyses are in progress.

Table 7. Estimated potential desert tortoise habitat on the Coronado National Forest (acres).

Ecosystem Management Area	Desertscrub	Desert Grassland	Total
Santa Catalina	93,949	1,820	95,769
Santa Rita	10,179	27,244	37,423
Tumacacori	8,020	77,992	86,012
Galiuro	11,124	6,000	17,124
Whetstone	12,513	0	12,513
Galiuro	409	0	409
Total	136,194	113,056	249,250

Tortoises on the Coronado NF appear to be more widely distributed and reach higher densities on the Santa Catalina Ranger District than on other districts. Tortoises are most common along the boundaries (especially western) of the Forest and along Redington Pass, because elevations rise quickly from Sonoran desertscrub along the boundaries to more montane biomes. The Santa Catalina Ranger District includes almost 5500 acres (2226 ha) of tortoise habitat within Catalina State Park, which is managed by the Arizona State Parks Board. Tortoises have also been recorded as high as 5300 ft (1615 m) in a single burrow in semidesert grassland vegetation interspersed with oak woodland. Much of the tortoise habitat in this district extends out of the Forest into Arizona State lands, private lands, and especially Saguaro National Park. The Nogales Ranger District also contains patchy tortoise habitat in semidesert grassland/Arizona Upland ecotonal communities west of the Pajarita Wilderness. This habitat extends into adjacent lands managed by Buenos Aires National Wildlife Refuge, Arizona State Land Department, and private individuals.

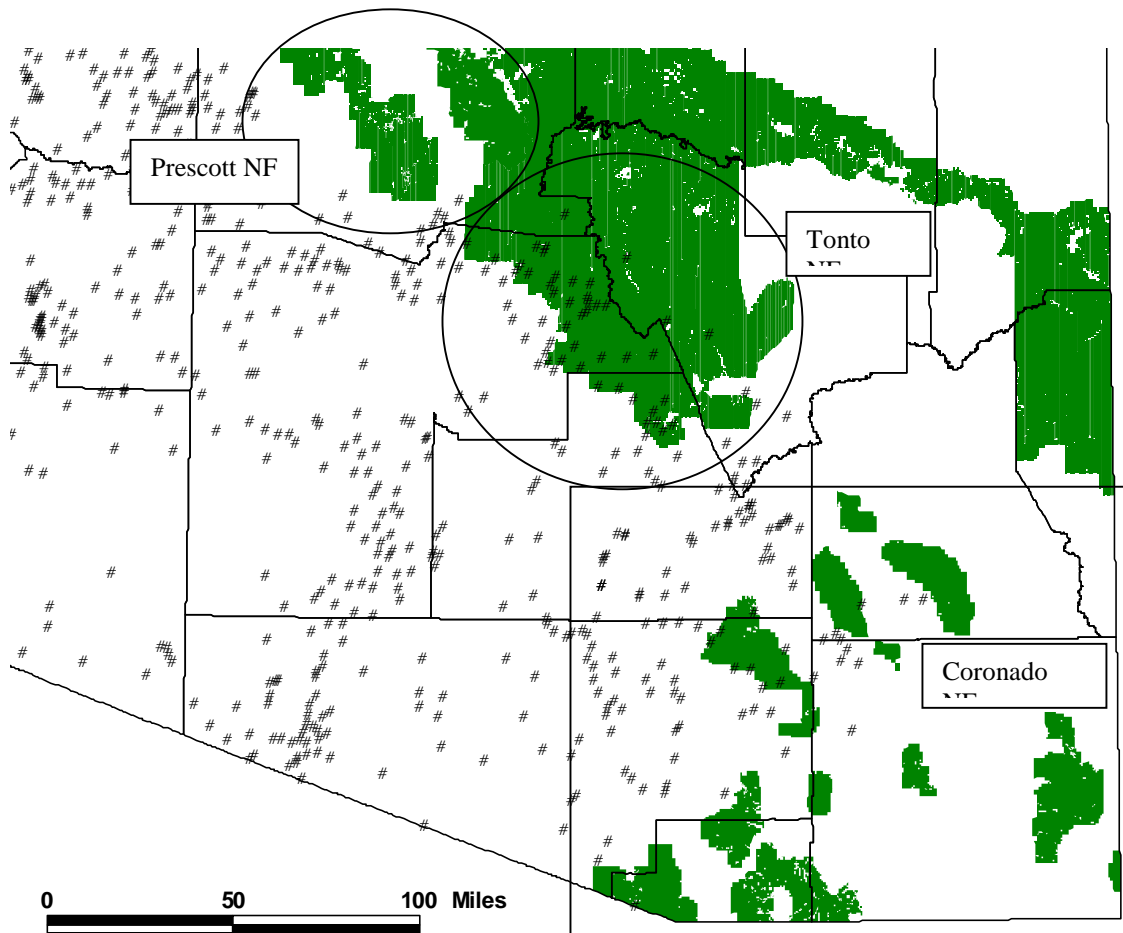


Figure 10. National Forest Service lands within the range of the Sonoran desert tortoise. AGFD Heritage Data Management System, 2000.

Although the Coronado NF Land and Resource Management Plan does not describe specific management direction for the desert tortoise, general wildlife management direction states:

Provide habitat for wildlife populations consistent with the goals outlined in the Arizona and New Mexico Department of Game and Fish Comprehensive Plans and consistent with other resource values.

Provide for ecosystem diversity by at least maintaining viable populations of all native and desirable nonnative wildlife, fish, and plant species through improved habitat management.

### Prescott National Forest

Relatively few tortoises appear to occur on the Prescott NF. Most tortoises on the Forest probably occur in low densities in the eastern foothills of the Bradshaw Mountains, west of Bumble Bee. This area is adjacent to Category II and III habitat on BLM and Arizona State lands. Some tortoises may possibly range onto the southwest side of the Prescott NF near Wagoner, but the area is near the upper elevation limit for tortoises in Arizona. As a result, few tortoises are expected to occur here. Little additional information on potential threats to tortoises and tortoise habitat has been provided to update Barrett and Johnson (1990), but cattle grazing, mining, and OHV activity occur in the existing habitat.

### Tonto National Forest

In 1993, Tonto NF estimated that it contained 106,954 acres (43,283 ha) of potential desert tortoise habitat (Tonto NF 1993), probably a dramatic underestimate, especially for lower-density populations. There may actually be closer to 400,000 acres (162,000 ha) of total potential desert tortoise habitat on the Tonto NF. Tortoises occur on 4 of the 6 ranger districts. Cave Creek and Mesa ranger districts have the largest amounts of high density tortoise habitat. In the most recent survey (1995), 114 adult tortoises per square mile were estimated at the Mazatzal Mountains on the Mesa Ranger District (Table 1). Globe Ranger District appears to have lower density tortoise populations in the southern portion of the district. The Tonto Basin/Roosevelt Lake area on the Tonto Basin Ranger District has only 3 historical tortoise observations, one of which may be of a released captive. If a tortoise population occurs in the basin it probably contains low numbers. Tortoise habitat on the Forest extends into adjacent lands managed by the Arizona State Land Department, BLM, Fort Mohave Indian Reservation, McDowell Mountain Regional Park, and private individuals.

Tonto NF has not provided updated information on current potential threats and tortoise management, so information more recent than Barrett and Johnson (1990) is limited. Few data on mining activities are available on the Tonto NF. Most mining activity is related to annual assessment work, which entails only minor ground disturbing activities. On the Globe Ranger District, exploration and potential mining activity has occurred near Superior. Since 1988 several fires have occurred in desert scrub habitat, especially along highways. Effects on tortoises have not been fully documented, but tortoise populations within these burns are thought generally to be of low density.

Of 103 grazing allotments on the Tonto NF (in 1990), 46 occur wholly or in part within the potential range of the desert tortoise. At least 4 allotments (Bronco, Millsite, New River, Sunflower) containing tortoise habitat were reviewed in the Tonto NF *Biological Assessment of the Effects [sic] of Ongoing Grazing Management on 25 Allotments* (March 31, 1999). Soil condition is considered to be in impaired to unsatisfactory condition on 19.3% (Bronco), 53.9% (Millsite), 51.2% (New River), and 60.5% (Sunflower) of each allotment. The Saguaro Wild Burro Territory is the only area on the Tonto NF that supports a population of wild burros. This territory is comprised of about 27,000 acres (11,000 ha) and is located north of Saguaro Lake. Studies have determined the optimal herd size to be 15, with capture and removal of animals beginning when numbers reach 25. As of July 11, 1989, the burro population was estimated at 16 animals. As of 1990, the population was not expanding, but more recent data were not available.

No significant urban areas exist within the Tonto NF. However, increasing human populations adjacent to forest lands may result in the take of tortoises, through vandalism or collecting for pets. Major roads and highway corridors have been in existence on the Tonto NF for many years. No major Forest Service road construction projects are planned. The Arizona Department of Transportation upgraded Highway 87 from 2 to 4 lanes through a portion of the best, high capability tortoise habitat on the Tonto NF. The Rio Verde highway, which was proposed by Maricopa County, would have fragmented existing desert tortoise habitat. The project was dropped in 1989 after it was found to be uneconomical, but may become viable in the future as the population of north Phoenix and Scottsdale increases.

The Tonto NF is currently working to provide for increasing recreation demands. New campgrounds and recreation sites have been developed at the south shore of Roosevelt Lake and the west shore of Bartlett Lake. Day use facilities at Saguaro Lake have been improved, and new facilities were developed at Apache Lake. Horseshoe Lake will remain undeveloped, but a launch ramp may increase dispersed recreation around the lake. The Bureau of Reclamation raised Roosevelt Dam, which will seasonally inundate additional land, eliminating vegetation and possibly burrow sites.

Major areas of OHV use on the Tonto NF within desert tortoise habitat occur in the Sycamore Creek and the Verde River/Box Bar areas. Several areas of potentially low-density tortoise habitat have been denuded of vegetation, causing extensive erosion, through the illegal creation of new trails. In 1990 the Tonto NF planned restrictions on vehicle and OHV use through the Resource Access Travel Management Plan. This plan was intended to restrict OHV use to designated roads and trails and to close many roads within tortoise range, but information on the current implementation of this plan was unavailable from Tonto NF.

#### BUREAU OF RECLAMATION

The Bureau of Reclamation (Reclamation) has not developed its own management policy for the desert tortoise. However, Reclamation does follow BLM guidelines (BLM 1988, 1990) and the *Management Plan for the Sonoran Desert Populations of the Desert Tortoise* (AIDTT 1996). Pursuant to NEPA and the Fish and Wildlife Coordination Act, Reclamation conducts surveys for desert tortoise in appropriate habitat and applies mitigation measures where impacts are unavoidable.

Reclamation has minimal land management responsibility; most activities related to desert tortoise management are associated with construction projects or ongoing Operation and Maintenance activities. In Arizona, Reclamation projects in or near desert tortoise habitat include the Desalting Plant and quarry operations near Yuma, the Central Arizona Project (CAP), Safety of Dam Repairs on reservoirs in central Arizona, and construction on Indian Reservations associated with implementation of water-rights settlement legislation. BLM has natural resource management authority along the Lower Colorado River and has set aside desert tortoise management areas along the river by Parker and Lake Havasu City. Potential impacts to desert tortoise from Reclamation activities include habitat loss and fragmentation.

Reclamation reduced potential tortoise impacts along the CAP aqueduct in the Picacho Mountains and in Avra Valley west of Tucson by: a) constructing 50 km of tortoise barrier fencing and 2 tortoise-accessible wildlife bridges; b) purchasing and protecting from future development 2513 acres (1017 ha) of habitat for tortoise and large mammals; c) constructing underground siphons at 6 desert washes to facilitate tortoise (and other wildlife) movement and to prevent habitat and population fragmentation; and d) implementing a tortoise removal and re-introduction program with pre- and post-construction telemetry monitoring.

The enlargement of Lake Pleasant resulted in the inundation of approximately 6462 acres (2615 ha) of desert tortoise habitat. Tortoise surveys of the inundation zone were conducted prior to reservoir filling, but no tortoises or dens were located within the inundation zone. Habitat impacts were offset by the removal of grazing on 30,011 acres (12,145 ha) of potential tortoise habitat around Lake Pleasant. The original mitigation commitment amounted to only a fraction of the protection realized by the extinguishment of grazing rights. Additionally, desert tortoise issues were considered during the planning of recreation facilities at Lake Pleasant. A tortoise fence was constructed along portions of South Park Road that bisected tortoise habitat.

At Roosevelt Lake up to 1800 acres (740 ha) of habitat will be impacted when the maximum Conservation Pool limit is eventually reached. The habitat quality for desert tortoise around Roosevelt Lake is low; few tortoises have been found in the area. Consequently, benefits to the tortoise from the grazing management on 27,903 acres (111,292 ha) of land around Roosevelt Lake will be limited.

In Yuma, desert tortoise habitat is primarily located near existing and proposed quarry sites. Surveys are conducted for desert tortoises at all proposed quarry locations. In addition, monitoring is continued at existing quarry sites and appropriate measures taken when tortoises are sighted.

Reclamation's Inter-Agency Coordination is centered around issues at Lake Pleasant Regional Park (Park). Reclamation coordinated with BLM on impacts to desert tortoise on BLM withdrawn land inside the Park. BLM's desert tortoise mitigation policy will be implemented for any future recreation-related impacts (to desert tortoises) at the Park.

#### BUREAU OF INDIAN AFFAIRS

The Bureau of Indian Affairs (BIA) has oversight responsibility for Indian trust lands (reservations) in Arizona. BIA is not a land management agency, however, and has not developed a management policy for the desert tortoise. Most management actions or policies regarding individual wildlife species rest with individual Tribes and their respective governments. The BIA conducts surveys for desert tortoises in appropriate habitat for those federal actions requiring NEPA compliance; however, this is more routinely done for the Mojave population due to its protected status under the Endangered Species Act.

Reservations known to, or that may, contain Sonoran desert tortoise habitat are: Fort Mojave, Colorado River, Hualapai, Fort McDowell, Salt River Pima-Maricopa, Gila River, Ak Chin, Tohono O'odham, Pasqua Yaqui, and San Carlos. The Tohono O'odham Nation (including the detached San Xavier and Gila Bend Districts) contains the most tortoise habitat by virtue of its size and the large amount of Sonoran desertscrub habitat type present. The Gila River and San Carlos reservations may also contain large tortoise populations relative to other Indian lands for similar reasons. The distribution and abundance of Sonoran desert tortoise has not been determined for any reservation in the state. Likewise, the precise areal extent of suitable tortoise habitat on tribal lands is unknown.

#### TOHONO O'ODHAM NATION

The Tohono O'odham Nation covers approximately 3 million acres (1,200,000 ha) of south-central Arizona and contains a considerable amount of potential habitat for desert tortoises (Fig. 11). Tortoises are known to occur on many of the numerous desert mountain ranges scattered throughout the Nation, but no systematic inventory has been conducted. A newly developed program within the Nation's Natural Resources Department, the Wildlife & Vegetation Management Program (WVMP), now has the primary responsibility for managing desert tortoises on Nation lands. In addition to managing wildlife and vegetation resources on the Nation, WVMP will provide education and training opportunities for tribal members and regulatory support for development activities (e.g., housing, transportation, economic ventures, utilities, etc.) on Nation lands.

Management of desert tortoises comprises only a small part of the overall scope of the WVMP mission. However, the desert tortoise (or komkud, as it is known in O'odham) is a species of great cultural importance to the O'odham people, and the program will actively work to preserve and protect the species on Tohono O'odham Nation lands. Because the program has only recently been established and because establishing a program to manage wildlife and vegetation on an area as vast as the Tohono O'odham Nation is a tremendous undertaking, specific management guidelines or objectives have not yet been formulated with respect to the desert tortoise. It is likely that the WVMP will conduct surveys to determine the distribution of the species on Nation lands and may establish a series of 1-km<sup>2</sup> plots to assess and monitor the status of the Nation's tortoise populations. Establishing such plots will ultimately depend upon the availability of funds and approval by the Nation's governing bodies. It is also likely that the desert tortoise will be afforded some level of protection under regulations that WVMP plans to develop. Any regulations developed with respect to wildlife or plant species must be approved by the Nation.

WVMP has conducted one activity with respect to tortoises in cooperation with the Arizona Department of Transportation (ADOT). State Highway 86 passes through several areas where tortoises occur, and in the past road mortalities have been a recurring problem. In 1998 WVMP and ADOT placed approximately 6500 linear feet (1980 m) of barrier fencing along identified "hot spots" where repeated road mortalities have occurred and have placed "tortoise crossing" signs along several additional roads throughout the Nation. Where possible, barrier fencing incorporates existing bridges or culverts, with the intention that tortoises following a barrier fence will be directed to these areas where they can safely cross under the road. Although there are insufficient data to quantify the

effects of barrier fencing and signs, it appears that the number of road mortalities has decreased in these areas (particularly where fencing has been erected). It also is unclear whether tortoises are using bridges and culverts to cross under roads on Nation lands. In the future WVMP will attempt to document use of culverts and bridges by tortoises in areas where barrier fencing has been installed.

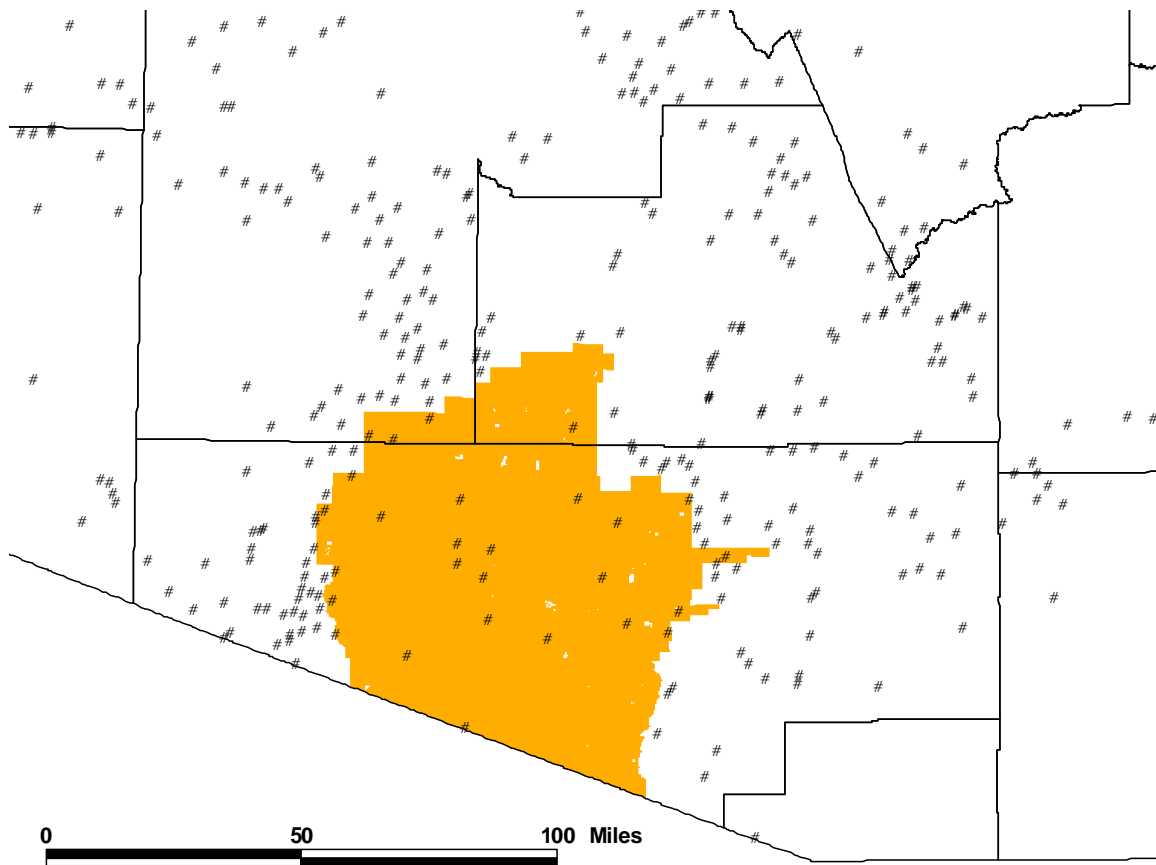


Figure 11. The Tohono O'odham Nation and Sonoran desert tortoise distribution. Each township and range occupied by Sonoran desert tortoises is represented by a separate point. AGFD Heritage Data Management System, 1999.

#### PIMA COUNTY

Pima County is currently in the process of developing a Sonoran Desert Conservation Plan (SDCP; Pima County 2000). As part of this process, land stewardship within the county has been closely evaluated (Connolly et al. 2000), and several additional reserves may be of conservation value to desert tortoises. The acreage of the Arizona Upland subdivision's paloverde-mixed cacti series provides a conservative estimate of potential desert tortoise habitat within these reserves (Table 8). These reserves receive pressure from surrounding urbanization, road fragmentation, and other

activities (Table 8), but all have permanent protection from conversion of natural land cover for the majority of their areas, with the exception of about 68% of Cienega Creek Natural Preserve (Connolly et al. 2000).

Table 8. Additional reserves in Pima County of potential conservation value for desert tortoises.

Reserve	Managing Entity	Paloverde-Mixed Cacti Acres	Permitted Activities <sup>a</sup>
Cienega Creek Natural Preserve	Pima County	1355	1,2,3,4
Colossal Cave Mountain Park	Pima County	134	4
Tucson Mountain Park	Pima County	14,309	3,4,5,6,7
Santa Rita Experimental Range	The University of Arizona	5481	8,9
Deeded lands	The Nature Conservancy	265	

<sup>a</sup>Permitted activities: 1) surface water diversions, 2) stock tanks, 3) hunting, 4) misc. recreation, 5) sewage treatment, 6) new roadways, 7) groundwater pumping, 8) new utilities, 9) grazing

Additional conservation actions relevant to desert tortoises have also been proposed as part of the SDCP planning process, including the proposed expansions of Cienega Creek Natural Preserve, Colossal Cave Mountain Park, Tortolita Mountain Park, and Catalina State Park; and the proposed creation of the Las Cienegas National Conservation Area, Santa Rita Mountain Park, and Cerro Colorado Ranch Conservation Area (Pima County 2000). Many of these proposed actions would further buffer tortoise populations from impacts related to urbanization and provide linkages between currently protected areas.

## SYNTHESIS

This report assembled a (mostly) current, comprehensive picture of management efforts for the Sonoran desert tortoise in Arizona. In this section we briefly assesses the adequacy of these efforts for the Sonoran population as a whole. We also identify areas where improvements might be possible and where multi-jurisdictional SDMAs might be considered, as recommended by the AIDTT's 1996 management plan, or where more focussed desert tortoise habitat management and conservation efforts might otherwise be directed.

BLM has management authority for the greatest proportion of habitat within the range of the Sonoran desert tortoise in Arizona (Figs. 4-5) and actively works to conserve tortoise populations and habitat, especially through its compensation policy and habitat categorization. Substantial tortoise habitat also occurs on ACECs and wilderness managed by BLM (Tables 5 and 6). Several other agencies take a more passive approach to desert tortoise management (at least as an individual taxonomic unit), but it is no less effective due to their particular missions. Most national wildlife refuges on which desert tortoises occur are managed as wilderness, effectively minimizing many of the threats identified in other areas. The same is true of national parks, and restricted access on the Yuma Proving Ground and Barry M. Goldwater Range affords near-wilderness status to tortoise habitat on those lands.

Most of the central and south-southeastern portion of the tortoise's range (Maricopa, Pinal, and Pima counties) occurs on relatively unprotected Arizona State and forest service lands (Figs. 3, 10, 12), although restricted access and cultural importance on the Tohono O'odham Nation may afford some protection there (Fig. 11). The southwest portion of the tortoise's range in Arizona (i.e., Yuma County and the western portion of Pima County) appears to be well covered by "wilderness"-level protection (Fig. 12), but most of this area is characterized by low-density, sparsely-distributed tortoise populations. The northwestern portion of the range also contains a significant amount of more actively managed tortoise habitat (wilderness and ACECs), but large gaps remain (Fig. 12). Most of the wilderness areas in the central to southeastern part of the state lie above the tortoise's elevational limits.

Important gaps in desert tortoise habitat protection occur near the metropolitan areas of Phoenix, Tucson, and to some extent Kingman, as well as intervening lands between these areas. These areas are under immediate pressure as more and more public land is being accessed for recreation by Arizona's growing urban population. Increasing recreational use results in increased opportunities for tortoises or habitat to be lost to roads (including trails illegally created by OHV enthusiasts), collection, and vandalism. Genetic contamination and introduced disease from released captives also pose increasing risks near metropolitan areas (see *Threats*, pp. 9-10). Proposed actions in Pima County's Sonoran Desert Conservation Plan would reduce pressures of urbanization on tortoise habitat within the eastern portion of the county (Pima County 2000).

We identified an important need to update comprehensive management plans to address increasing demands and impacts on BLM lands, but this could be applied to other public lands, as well. In

addition, even though wilderness-level status may offer some protection against urbanization (at least the effects of direct habitat loss), roads and OHV activity, and grazing and mining (in some cases), land managers must realize that other threats, especially exotic plant invasion and fire, are not constrained by artificial boundaries. Wilderness and other areas may also be affected by the unknown long-term effects of habitat fragmentation by urban and agricultural development, roads, and canals. Even though market conditions are not particularly good for gold and other hard rock minerals at present, mining claims are numerous throughout the range of the desert tortoise. Protection is somewhat limited on many federal lands by the 1872 Mining Law, unless areas such as wilderness, national parks, and refuges are withdrawn from mineral entry. Resources are desperately needed to adequately implement existing policies and enforce existing regulations on many public lands.

Given the information currently available, tortoise populations appear to be stable within the Sonoran Desert in Arizona. However, trend data are currently insufficient to draw secure conclusions about population trajectories (Averill-Murray 2000), especially with the increasing threats related to urban growth and habitat fragmentation. The ability to detect trends is negligible if populations are only surveyed 2 or 3 times, thus requiring a long-term commitment to population monitoring in order to detect anything other than a catastrophic decline (Averill-Murray 1999). With the exception of 1990-94 when 3 plots were surveyed annually, monitoring efforts have been haphazard (Table 1). Several plots have been surveyed across long time intervals or have yet to be resurveyed at all. Inconsistent funding will result in an increased period of time before trend estimation is possible for each plot. Long survey intervals could result in gradual declines over several years not being detected until a significant absolute decline in abundance has already occurred. Catastrophic declines (such as that at the Maricopa Mountains; Shields et al. 1990) might not be recognized as such, reducing the ability to identify and correct the cause of the decline (Averill-Murray 1999). Finally, little more than general distribution data exist for tortoise populations on lands managed by the Department of Defense, U.S. Forest Service, national wildlife refuges, and the Tohono O'odham and other Native American nations.

The unknown significance of currently low incidence of URTD symptoms but high incidence of cutaneous dyskeratosis within tortoise populations poses another concern; apparently healthy populations in the Mojave Desert have suffered dramatic declines in the presence of these diseases. Continued monitoring across the range is essential to better quantify population status and trends. Individual and cooperative efforts by land and wildlife management agencies must continue to ensure that sufficient habitat area and quality remain for the survival of tortoise populations. Finally, additional research should be conducted to answer questions about population dynamics, habitat impacts (especially fire and invasion of exotic grasses), and disease, so managers can better direct their conservation efforts (AIDTT 1996).

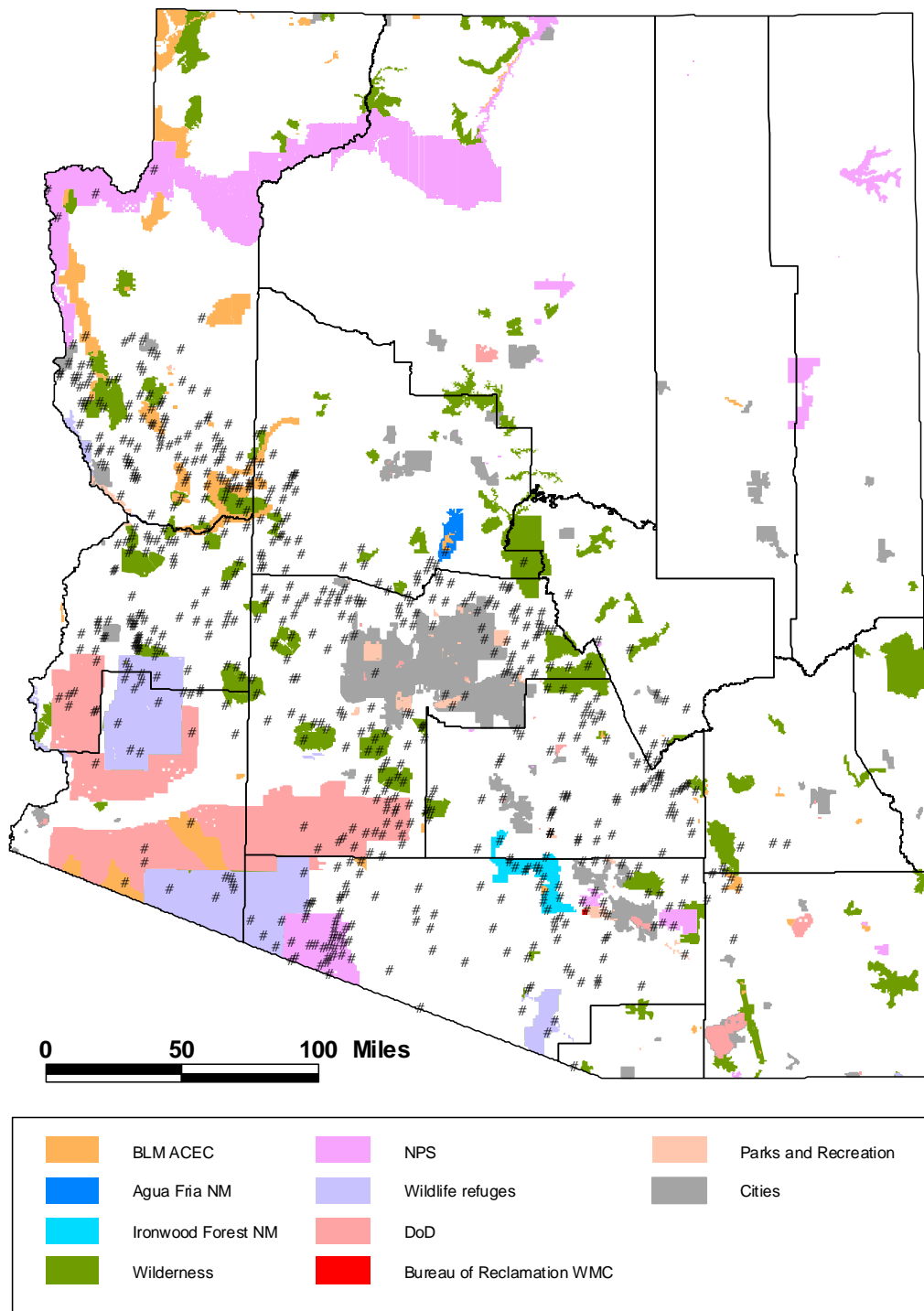


Figure 12. Sonoran desert tortoise habitat receiving park or wilderness-level protection. Each township and range occupied by Sonoran desert tortoises is represented by a separate point. AGFD Heritage Data Management System, 1999.

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